Daisuke Taira
Science Hero Project

Jonathan Shanklin

Discoverer of the ozone hole in 1985

○ Plan

1. What evidence is there the ozone hole formed over Antarctica?
2. What factors are supposed to cause the ozone depletion?
3. What effect does the ozone hole have?
4. What prediction of ozone hole is considered?

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○ Jonathan Shanklin

Jonathan Shanklin is a member of British Antarctic Survey (BAS) who discovered the Ozone Hole over Antarctica with his two colleagues, Joseph Farman and Brian Gardiner in 1985.

He was born in Wrexham, North Wales, and he developed his scientific study at the University of Cambridge through King's school, and Chester and Magdalene College. He has been working in the Meteorological and Ozone monitoring Unit at BAS since 1977. He is also in control of operational part of the BAS meteorological observing programme.

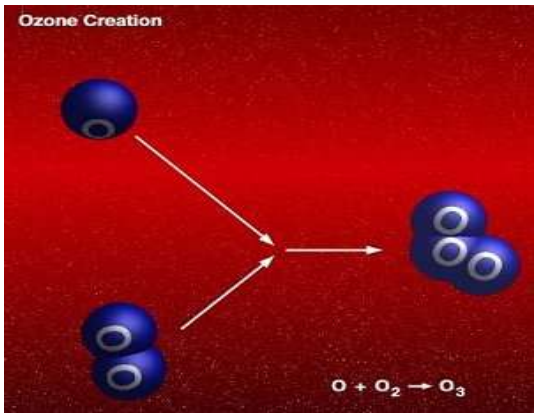
Due to his works, he has received some awards such as a Blue Peter Badge for the discovery of Ozone Hole, and recently the Society of Chemical Industry Environmental Medal, the Institute of Physics Charles Chree Medal and Prize.

As his interests, he is a treasurer and manages the website of the BAS cricket team as well as he plays Ice Hockey. Apart from that, he is keen on nature conservation as a vice President of the Cambridge Natural History Society. In particular, his fascinating concern is an amateur observation of the solar system and stars.

○ What Is The Ozone Layer

The Ozone Layer consists of ozone molecules (O_3) which are made up of three oxygen atoms. The layer exists in between 10km and 40km above the earth surface in Stratosphere that locates just above the Troposphere in which we live and most weather causes. In fact, the layer is the thinnest in the tropic (around the equator) and then thicker towards the Polar Regions. Its concentration in the atmosphere is measured by Dobson Unit. For example, the average of the ozone concentration in the atmosphere is approximately 300 Dobson Units.

The role of this layer is to protect the earth's surface against ultraviolet (UV) from the sunlight. Ozone is naturally formed when the UV gets into the stratosphere, decomposing O_2 into O, and then O bonds with further O_2 immediately to form ozone molecule.



$$O_2 + hv \rightarrow O_2 + O$$
$$O + O_2 \rightarrow O_3$$

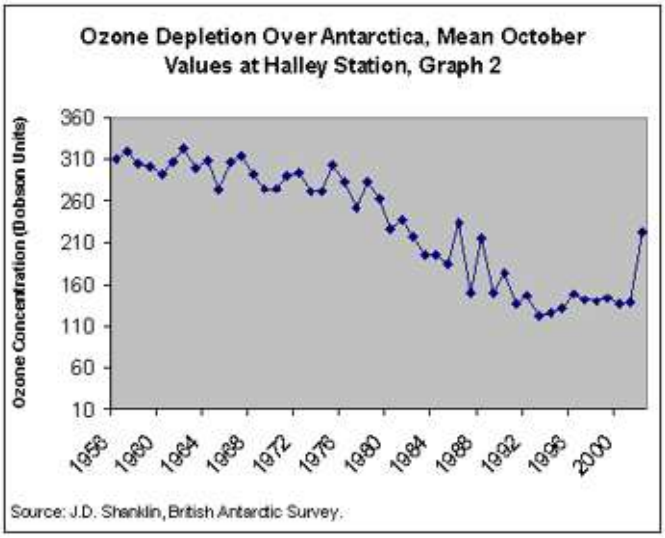
(hv: potentially harmful ultra-violet at wavelength 240 - 320 nm)

Ozone in the stratosphere is essential for life on Earth because the Ozone layer absorbs some of the potentially harmful UV radiation from the sun. On the other hand, it is quite toxic at ground level as a main factor of photochemical smog. It can cause living things asthma, other chronic respiratory disease and lung disease, harming lung function. In addition, it affects the loss of the agricultural crops and damages leaves of the crops.

○ Ozone Hole Over Antarctica

In the early 1980s, a gap in the Ozone Layer over Antarctica so-called "Ozone Hole" was observed by Jonathan Shanklin. The possibility of this phenomenon was predicted by Dr. Roland and Dr. Molina in 1974.

The observation of the Ozone Hole has begun with Dobson Unit during every Antarctic spring (September to November) since 1980.



According to the data in which Dobson Unit shows the change in the concentration of ozone over Antarctica, it has been depleting remarkably since the late 1970s, and its figure is less than half the standard figure (300 Dobson Unit) around 1993. However, we can see the recovery of the ozone level recently.

The ozone depletion was mainly caused by a man-made chemical, Chlorofluorocarbon compounds (CFCs) and bromofluorocarbon compounds. Refrigerants and aerosols represent the common industrial products containing CFCs.

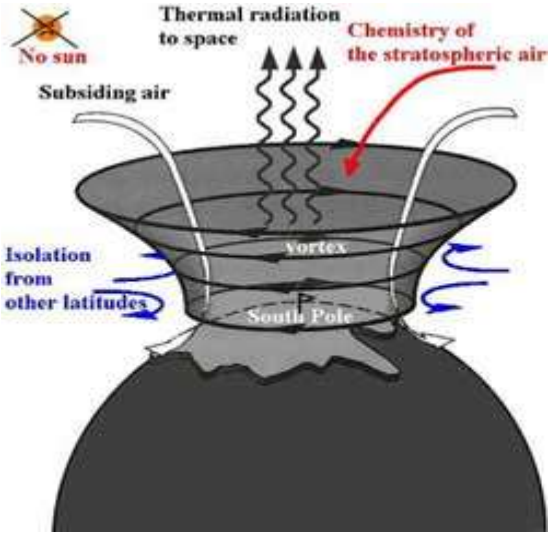
In the stratosphere, the CFCs are split up into CFCl and Cl by UV. The Cl can then breakdown the ozone compound through a variety of processes. For example, a chlorine atom reacts with ozone molecule, obtaining an oxygen atom to form ClO and releasing an oxygen molecule. Then a free oxygen atom takes an oxygen atom away from the ClO to reform O_2.

$$Cl + O_3 \rightarrow ClO + O_2$$
$$ClO + O \rightarrow Cl + O_2$$

The O_2 produced can still rebuild an ozone molecule, binding with another oxygen atom. Even though the recombination system exists, the total tendency leads to the decrease in the volume of ozone in stratosphere.

The destruction of the Ozone Layer is also affected by the physical condition in the polar region.

The Circumpolar vortex created in winter which arises a stormy wind, efficiently separates Antarctica from the rest of the world. This strong and stable vortex prevents the ozone moving to the stratosphere over Antarctica from the tropic regions near equator in which have a higher formation of ozone.



The extremely cold winter (below -80℃) forms special clouds called Polar Stratospheric Cloud that acts as the site of the ozone-destructing reaction, although clouds are not normally formed in the stratosphere. This cloud speeds up the destruction of the Ozone Layer, packing high concentrations of both ozone molecules and ozone-depleting substances. During the early spring, the long period of sunlight in Antarctica activates chlorine and other catalytic chemical factor to destroy ozone, resulting in the Ozone Hole. The cloud disappears as it becomes warm.

Therefore, the depletion is occurred between late winter and early spring.

○ Problems with the Ozone Hole

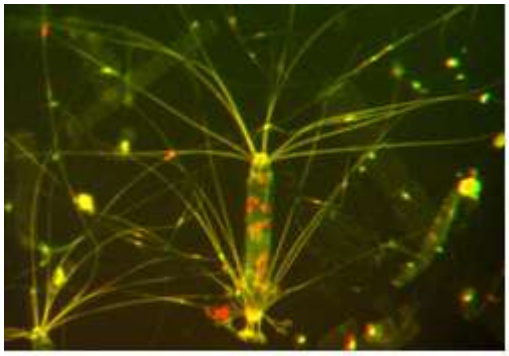
As the Ozone Layer depletes, more UV radiation reaches the earth's surface through the stratosphere. UV-B (280~315nm), which is referred to the harmful UV, can have problematic effects on human health, plants and marine ecosystems.

Prolonged exposure to UV-B can cause premature aging of skin, skin disorder and even skin cancer, damaging the immune system which protects the skin. In fact, there has been an increase in skin cancer sufferers of 7% every year in U.K.

The effect of UV-B on human also affects their eyes such as cataracts which is the clouding of the lens in their eyes usually by aging process or illness.

Plants extremely exposed to UV-B may result in the lower crop yields due to reduced resistance against disease. Therefore, a number of economically important plants such as rice have been affected by the increased UV-B.

In addition, its effect leaded to marine ecosystem. The productivity of phytoplankton, the basis of marine food webs, is reduced by the enhanced UV-B. It also affects dependant species such as fish, seal, penguin an d whale in southern ocean.



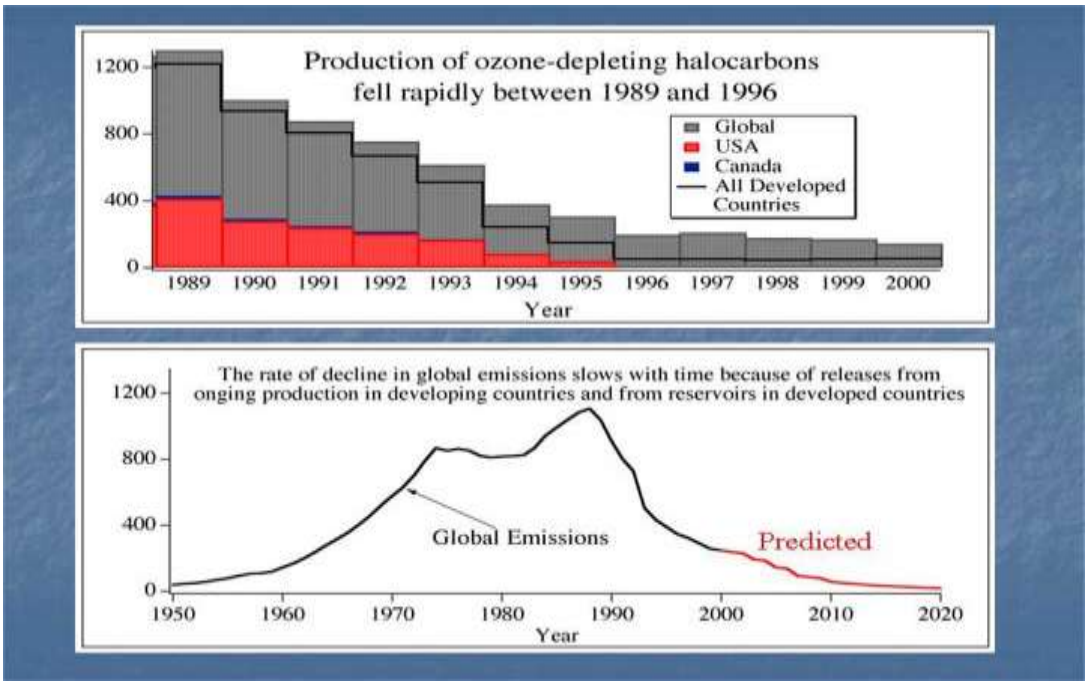
Polar phytoplankton collected on Cochlan's research voyage in Antartica's Southern Ocean

There are still some impacts of UV-B on life ,environment and climate on earth.

○ Is it possible to recover?

Because of the discovery of the Ozone Hole in Antarctica by BAS scientists in 1985, the Montreal Protocol on Substances that Deplete the Ozone Layer was adopted in 1987 as the first international treaty created on the basis of scientific evidence.

It regulates the production and consumption of ozone depleting substances. In 1990, 80 countries agreed to phase out the production and consumption of CFCs, halons and carbon tetrachloride by 2000 and methyl chloroform by 2005. They also have attempted to phase out methyl bromide since the meeting in 1995, which then brought forward the phase-out of methyl bromine to 2005 for developed countries and to 2010 for developing countries.



As long as we regulate this agreement, scientists believe that the Ozone Hole will recover eventually as in 2005, current computer models predicted

that the Ozone Hole should recover globally by 2050. However, recent analysis suggested the hole won't heal until about 2070. Investigators suspect that is because the old refrigerators and car conducting system containing ozone-killing chemicals are still used in America and Canada

There are also some other causes to delay the recovery, for example, illegal trading of CFCs. So healing of the ozone level might be prolonged to 2100.

Even though the whole world stopped releasing ozone depleting substances tomorrow, the total recovery is supposed to take until about 2050.

Therefore, we, individuals, should think what we can do and take action as quick as we can for life on earth and earth itself, which have often been poisoned by human activities, on the worldwide scale.

○ Conclusion and Evaluation

The discovery of the Ozone Hole over Antarctica by Jonathan and his colleagues warned us that life on earth would be in danger in the near future.

It is, in fact, mainly caused by human made substances such as CFCs and the typical Antarctic weather. As a result, more ultra violet light can reach the earth's surface through the depleted ozone layer. The prolonged exposure to UV seriously can damage to human health, plants, marine ecosystem and so on.

A number of countries have been cooperating with each other for the global issue since they signed the Montreal Protocol on Substances that Deplete the Ozone Layer in 1987. As long as this long-term attempt to phase out the production and consumption of ozone killing substances are maintained, scientists suggest that the ozone layer will recover by about 2070, although its prediction may be delayed by some reasons such as the illegal CFCs trading.

If the ozone hole had not discovered and human beings had been still emitting the ozone depleting substances, many more people and other living things would have been suffered from effect of UV.

Consequently, the announce of this discovery by BAS could be said that it led to save the world as the Montreal Protocol was adapted as soon as its discovery was published. Despite ozone layer has not healed yet, it is likely to go well.

The information for this issue on the Internet has often varies with the years in which the reports by groups of scientists were published, since this global issue has not been solved yet and there may be still some problems

which we have not found yet. So it was quite hard to obtain the right information, choosing the latest information.

○ Bibliography

*All the sources of information that I derived for the assignment were:

Details

British Antarctic Survey: http://www.antarctica.ac.uk/

The Ozone Hole Tour: http://www.atm.ch.cam.ac.uk/tour/

The Ozone Hole: http://www.theozonehole.com/

Live Science: http://www.livescience.com/

The Antarctic Ozone Hole: http://www.coolantarctica.com/Antarctica%20fact%20file/science/ozone_hole.htm

Images

Jonathan Shanklin: http://www.flickr.com/photos/davepearson/430264545/
http://www.flickr.com/photos/davepearson/430264345/

Others: http://images.google.co.uk/imghp?hl=ja&tab=wi

Power Point: mhtml:http://www.stevenson.ac.uk/heroes/sce/biology/daisuke%20taira.mht!DaisukeTaira_files/frame.htm