Ozone Layer

What is the Ozone Layer?

Ozone is a naturally occurring gas found in the atmosphere where it absorbs most of the sun's ultraviolet light - invisible rays which are harmful to both plant and animal life.

Ozone is found throughout the atmosphere including at ground level, but is mostly (about 90%) found in a band called the
ozone layer
at about 15 - 30 km above the Earth's surface, in the stratosphere, the height at which larger aircraft fly. It is n ot really a ?layer? at all but one of many gases found in the stratosphere.

The ozone layer is essential for life - until it was formed, about a billion years ago, the only life on Earth was at the bottom of the ocean. It is thought that single celled organisms released oxygen through photosynthesis.

The Science

The stratosphere is a layer of gas that starts somewhere between 12.9km (over the Poles) and 19.3 km (over the Equator) above the surface of the Earth, depending on where you are and ends almost 50km above us! T he stratosphere has virtually no clouds or weather. When oxygen molecules (O2) reach the stratosphere and are hit by strong ultraviolet rays from the sun?s they can split up into two separate oxygen atoms (O2 + UV = 0 + 0). If one of these joins on to an oxygen molecule, it forms an ozone molecule, which is O3 (O2 + O = O3).

At lower levels in the atmosphere ozone acts as a greenhouse gas helping trap heat and so contributes to global warming. At ground level it is a poisonous gas and can cause health problems such as asthma and b ronchitis. It is formed by the action of sunlight on carbon based chemicals (volatile organic compounds) when t hey are combined with a group of pollutants called nitrogen oxides.

Destruction of the Ozone Layer - The Causes

Chlorofluorocarbons (CFCs) have been identified as the main cause of the destruction to the ozone layer, but there are also compounds containing bromine, other halogen compounds and also nitrogen oxides which cause damage.

CFCs were discovered by Thomas Midgeley in the 1930s as a cheap, non-flammable, safe coolant for r efrigerators. They have been used in refrigerators, air conditioning, fast food packaging and propellants. C FCs are very stable, they decay slowly and so endure in the atmosphere for up to a century.

CFCs rise and gradually accumulate in the stratosphere where they are broken down by the sun's ultraviolet light, so releasing chlorine atoms. The chlorine attacks the ozone, one chlorine atom can help to destroy 100,000 ozone molecules.

The Effects

With the chlorine from CFCs destroying the ozone, more ultraviolet light is able to reach the Earth's surface, with harmful effect to human and plant life. The harmful radiation is known as UV-B.

UV-B radiation can cause skin cancer, cataracts and increased infections through the skin. It is estimated that a 10% loss of ozone above Britain could cause an extra 8,000 cases of skin cancer every year. Australia has t he highest rate of skin cancer in the world.

UV-B radiation has an adverse effect on plants and is in particular a threat to phyto-plankton, the single cell plants that all marine life depends on, as they are highly sensitive to UV-B radiation. This could upset the ocean food chain on which many marine creatures rely on such as shrimps, crabs, penguins, seals and whales and which we depend on for fish. Plankton is a good air filter absorbing millions of tons of carbon e

ach year, about half of what the world produces and also produces much of our oxygen!

The Antartic Ozone Hole

A hole in the ozone layer, covering an area larger than the Antarctic continent, was discovered in 1985 by Joe Farman and his colleagues on the British Antarctic Survey. They discovered a general thinning over the whole globe - a 3% decrease since 1969, but with greater depletions in middle and higher northern latitudes in winter. Every winter the ozone layer was thinning by up to 8% over Europe.

Why the Antarctic?

In some areas the ozone layer has deteriorated by 20%, but above the Antarctica, this can be up to 65%! S ince about 90% of the chlorine in the atmosphere was emitted by industrialized nations, you would expect that any hole would be over one of those countries! However, ozone depleting chemicals (ODCs) are non-r eactive which means that they can remain in the atmosphere for decades. It is only when they are hit by UV l ight in the stratosphere that they break apart and do their damage. By this stage they may be in totally d ifferent places from where they began. The extreme lower temperatures in the Antarctic can speed up the r ate at which the CFCs are converted into chlorine.

Antarctica is the coldest place on earth - at times colder than Mars! During the winter time, the sun doesn?t ris e over the continent temperatures can drop below minus 78 degrees centigrade for up to six months. This e xtreme cold is responsible for the formation of special ice clouds known as ?polar stratospheric clouds? on the surface of which chlorine gas is created. Though chlorine is stable and does not react with ozone, it is easily b roken down by UV light into chlorine radicals, which break down ozone.

When temperatures rise in the spring, ozone depleted air that had been concentrated over Antarctica moves over other countries in the southern hemisphere such as Australia, New Zealand, and South America.

At times there is also a smaller hole over the Arctic but the colder temperatures necessary for the formation of the polar stratospheric clouds may only last a month or two. However experts have found concentrations of c hlorine there 50 times greater than expected.

The Montreal Protocol

In 1979 the USA and Scandinavia banned CFCs in aerosols. In 1985 the United Nations Convention on Protection of the Ozone Layer was drawn up. This was the first practical step towards limiting CFCs.

On 1st January 1989 the Montreal Protocol came into force. It was the actual agreement to reduce consumption of CFCs Two revisions of this agreement have been made since then, the latest being in 1992. At first it was signed by 25 countries but now 191 countries are signatories. The Montreal Protocol commits t hem to cut CFC production by half by 2000 and nearly to stop producing 100 other ozone depleting substances by 2010.

Green consumerism helped to enforce this agreement as 'CFC - free' aerosol cans and plastic foam c ontainers became available to buyers. Now HCFCs have replaced CFCs which are not as damaging but are t o be banned in the EU from 2015. They are still used in some fast food foam packaging.

From the 1st January 2000 CFCs were banned from all new refrigerators and freezers. It became possible to take away old fridges so that the CFCs could be recovered and recycled. All fridge manufacturers in the E uropean Union now have to accept back their old fridges and dispose of the components safely.

The amount of chlorine in the atmosphere is now decreasing but to return to pre-1980 levels of ozone will take some time because the ozone depleting substances remain in the atmosphere for decades. In the UK C FCs were still being used in some insulating foam until 2005. Equipment is still exported illegally to d eveloping countries where they may not be able to afford the alternatives.

Good News

In the spring of 2006 the hole in the ozone layer was the largest it has ever been at 10.5 million square miles, larger than Antarctica itself! This was due to a number of factors, natural conditions as well as man-made. Ho wever since that ozone levels have remained static and although it has not yet started to decrease in size, most scientists agree that unless factors change, the hole should disappear within the next 70 years and

outside of polar regions ozone levels should return to pre-1980 levels by around 2048.

Monitoring the Ozone Layer

From 1996 - 2006 a NASA Earth Probe space craft collected data until its transmitter failed. Now spacecraft A ura, launched in 2004, is collecting data on a fortnightly cycle about many regions of the world. The UN a nnounced in 2008 the establishment of a new station in the Persian Gulf to monitor the climate and ozone levels.

The Ozone Layer & Climate Change

These two separate issues are often confused but they are related. Some scientists think that global warming c ould have a negative effect on the recovery of the ozone layer. Some proffered solutions to global warming c ould help resolve one problem, whilst exacerbating another. Take the idea of releasing sulphur compounds i nto the atmosphere, mimicking a volcano. This would have a cooling effect but could cause greater ozone d epletion.

Ozone depletion has a cooling effect! Conversely as the hole over Antarctica heals up, it most probably will l ead to temperature rises! But we need the ozone layer to survive!

What You Can Do:

Make sure that you dispose of your old fridge or freezer correctly - ask your local council.

Write to fast food manufacturers asking them not to use HCFCs in their foam packaging.

Other products may contain other ozone depleting chemicals or chemicals which harm the environment in

other ways. Many household cleaning products and even air fresheners can make the air more polluted in a h ome than the air outside! These may have a detrimental effect on human health too.

Try to avoid spray aerosols; use pump action sprays where possible instead.

Old halon type fire extinguishers should be disposed of correctly.

Useful websites:

Ozone depletion -
http://www.ozonedepletion.co.uk

National Geographic -
http://environment.nationalgeographic.com/environment/global-warming/ozone-depletion-overview.html

Ace Resources -

http://www.ace.mmu.ac.uk/resources/teaching_packs/key_stage_4/climate_change/03p.html

Related links:

Conservation Education - Wildlife and Climate Change.

Factsheet:

Antarctica

Environment - how you can help to protect it.

Pollution

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