George Philander – Is the Temperature Rising? The Uncertain Science of Global Warming, Princeton University Press, Princeton New Jersey, 1998 - 2

Chapter 3 dealing with Absorption and Greenhouses Gases, page 44 to 52 and Glossary of Terms

Chapter 3 explains Absorption of Light, Greenhouse Gases and Thermal Structure of the Atmosphere. The Glossary has a specific definition and description of the qualities of carbon dioxide.

Some gases in the atmosphere absorb ultra violet and others infra-red light. This is relevant to the scientific investigation of climate change and global warming. Ozone absorbs ultra violet wavelengths but the earth itself radiates infra-red wavelengths back. The wave theory of light could not explain certain phenomena at extremes. Quantum theory surpassed it. This postulated that light or heat travels in packets (or quantums). The colour emitted by different 'wavelengths' reflects different quantums of energy. The longer the wave the smaller the quanta of energy (e.g. infra red 'longwaves'). The shorter the wave the greater the quanta of energy (i.e. ultra violet 'shortwaves').

Quantum Theory is relevant to climate science. Einstein showed that different materials absorb different quantums of energy. After Einstein scientists called these quantums "photons". The most energetic photons are dangerous to existing molecular cells.
They come in from the sun. Upper atmospheric particles deflect these photons. Those that reach the earth's surface are harmless.

Gases like Ozone absorb the dangerous photons high up in the atmosphere. The photons knock electrons off atoms and are 'absorbed' by these gases. The earth's surface absorbs those photons reaching it, heating the surface. This in turn radiates photons back to space. These are long, infrared photons with less energy than the incident ones.
Gases can only absorb those photons that are able to knock an electron from one orbit to another. Carbon dioxide, vapour and ozone molecules absorb both infra red and ultra violet rays. Oxygen and nitrogen are by far the most abundant gases in our atmosphere. But oxygen and nitrogen molecules can only absorb incoming ultra violet photons. The low temperature of the earth's surface means that it radiates infra-red photons. These are "lethargic" compared to the movement of ultra violet photons (or x-rays).

Molecules of different gases vibrate at different frequencies. Their electrons circulate around their nuclei in different but specified orbits. Gases absorb those photons capable of knocking their electrons from specified orbit to orbit. Different gases absorb photons with the energy quanta required to change their molecular state. The quanta of energy 'bumps' electrons from one orbit to another. The more complex a molecule the greater the range of photons that it interacts with (i.e. 'absorbs'). Nitrogen and Oxygen are simple molecules and interact with energetic ultraviolet rays. Carbon dioxide, water vapour and ozone have a larger repertoire (including the infra-red photons).

Carbon dioxide accounts for only 0,035 per cent of the earth's atmosphere. This equals 355 parts per million (ppm) at sea level. But the concentration has been rising because of our industrial and agricultural activities. Carbon dioxide is an effective absorber of infrared radiation at wavelengths centred on 15 microns. Ozone at wavelengths close to 10 microns. Water vapour over a large range of wavelengths (five to eight microns and 11 to 100 microns).

There are ‘open windows” – ranges of wavelengths – where the heat escapes unabsorbed to space. If there were more CFCs released in to the atmosphere these would close these windows. They would absorb heat at those wavelengths. Extra carbon dioxide and ozone will amplify the green house effect. But CFCs will amplify the effect faster. There is already much extra quantities of carbon dioxide and ozone in the atmosphere. Whereas new CFCs would be operating in an ‘open window’. Water vapour is also a powerful greenhouse gas. But its concentration varies depending on the temperature. With higher temperatures there is more vapour, and with lower temperatures less vapour.

(summarised by Paul Hendler)