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The ozone layer and ozone depletion

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The ozone layer

Ozone is created by the action of sunlight on oxygen high in the stratosphere where the air pressure is very low and sunlight very strong.

Lower down in the stratosphere, ozone is naturally destroyed in reactions with other atmospheric gases and the ozone layer is a consequence of the creation and destruction processes.
About 300,000,000 tonnes per day of ozone are involved in this cycle[1].

The ozone layer exerts two important influences on the atmosphere:

- the processes that create and destroy ozone generate heat, so that the ozone layer controls the temperature of the stratosphere; consequently the stratosphere is warmer than the atmospheric layer immediately below it (the upper troposphere), and
- ozone absorbs the higher energy parts of the ultra-violet (UV) irradiation coming from the Sun (all of the UV-C and most of the UV-B).

Formation of ozone is controlled by sunlight; this means that most ozone is formed over the Equator and almost none over the Poles. The ozone in the stratosphere at the Poles was transported there on stratospheric winds.

Ozone depletion occurs if the processes that destroy ozone are augmented, so that the balance between its formation and removal is disturbed. This makes the Polar stratosphere particularly vulnerable (because ozone is not formed there).

A large number of chemical species are involved in the natural ozone removal processes: water, hydrogen peroxide, hypochlorous acid, nitric acid, methane, carbon monoxide, nitric oxide, nitrogen dioxide, nitrous oxide, chlorine, chlorine monoxide, hydrochloric acid and bromine monoxide all play a part. The removal process is also augmented by reactions that occur on the surface of particles; in turn these are influenced by stratospheric temperatures [2]

The most important parameters now are the chlorine and bromine concentrations and the existence of stratospheric particles (such as ice clouds).

Because it is a consequence of an upset to the balance between formation and removal, ozone depletion is temporary. In the short term, the lower ozone levels that result are regional and seasonal (like the Antarctic ozone hole) and, in the long term, ozone depletion should cease when the balance is restored.

Because ozone absorbs solar UV radiation, low ozone levels in the layer coincide with an increase in the flux of UV-B into the lower atmosphere, although this does not necessarily mean a higher flux at ground level [3]. The concern is that, if ozone depletion were to persist, the average UV-B flux could increase.

Sources:

1. Chapman S., A theory of upper atmospheric ozone, Mem. Roy. Met. Soc., 3, 103-125, 1930.
2. Stratospheric Ozone, First Report of UK Stratospheric Ozone Review Group, HMSO, London, 1987.
3. The Potential Effects of Ozone Depletion in the United Kingdom, First Report of the UK UVB Measurements and Impacts Review Group, HMSO, London, 1996.