Ozone layer recovery may be delayed by greenhouse gas emissions

The ozone layer in the stratosphere protects life on Earth from harmful radiation, but emissions from human activity have damaged this defence. A new study suggests that ozone recovery could be delayed, or even postponed indefinitely for some regions, by the impact of increasing amounts of greenhouse gases (GHGs) in the atmosphere.

Although ozone at ground level is hazardous to health, ozone in the stratosphere protects humans, other animals and plants by absorbing harmful ultraviolet radiation. The stratosphere is the layer of the atmosphere between 10 and 50 km above Earth. Reactions between oxygen and sunlight in the stratosphere form ozone. However, the release of ozone depleting substances (ODSs) from human activity can destroy the ozone molecules. ODSs are typically compounds composed of carbon and halogens (e.g. chlorine, bromine). For example, CFCs (chlorofluorocarbons), which have been used as aerosol propellants, in refrigeration and foam blowing.

The greatest atmospheric levels of ODSs are thought to have occurred around 2000. Levels then dropped following successful restrictions on the manufacture and use of ODSs under the Montreal Protocol¹ and amendments and EU regulations². The World Meteorological Organisation (WMO)/United Nations Environment Programme (UNEP)³ expects ODS levels to return to pre-1980 values during the second half of the 21st Century. However, climate change could affect this ozone recovery.

The researchers modelled the impact of increasing amounts of GHGs in the atmosphere on the recovery of ozone levels in the stratosphere. Two significant milestones were evaluated: “Ozone returning to historical values” and “Ozone being no longer significantly influenced by ozone depleting substances”. The study concluded that reaching either of these milestones was likely to occur at different times in different regions in the world.

Even if ozone values return to the historical reference level (pre-1980 when no significant impact of ODSs had been detected), this might not necessarily be due to complete removal of ODSs from the stratosphere, but rather due to the effects of climate change.

Both GHGs and ODSs influence ozone concentrations in the atmosphere at different latitudes and at different heights above the Earth’s surface. The results of the study suggest that, by the end of the 21st century, there will be greater than pre-1980 concentrations of ozone in the upper stratosphere, but lower concentrations in the lower stratosphere in the tropics and southern mid-latitudes.

Climate change causes variations in circulation patterns in the lower stratosphere in the tropical and mid-latitudes. This causes faster movement of air through these areas, so less ozone is formed. The researchers suggest ozone will never return to pre-1980 levels in the tropics, even if ODSs no longer remain in the stratosphere. Greater exposure to UV radiation has health implications, potentially causing more skin cancer in Australia and South America, for example. In contrast, GHGs in the upper stratosphere cause cooling, slowing reactions which destroy ozone, allowing restoration of the ozone. Therefore ozone levels should return to pre-1980 levels several decades before the influence of ODSs has ceased, particularly in northern mid-latitudes.

Projected increases in GHGs will have a major impact on the ability of the ozone levels to recover in the stratosphere and there will be significant variations in recovery in different regions. This implies that monitoring of ozone recovery should take account of the effects of climate change and separate assessments should be made for the different regions.

2. See: http://ec.europa.eu/environment/ozone/community_action.htm


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