13. Planetary boundary 7: Stratospheric ozone depletion

Introduction

Stratospheric ozone refers to the layer of the atmosphere between 20 and 50 km altitude. By filtering out a large part of the solar ultraviolet (UV) radiation, mainly UVC and UVB rays, this layer protects living beings, overexposure to UV rays that can have harmful effects on human health (cataracts, skin cancer, weakening of the immune system) and on plants (inhibition of the photosynthetic activity of plants). Guaranteeing the integrity of the ozone layer is therefore a major issue, its excessive thinning, or even its disappearance in certain areas, which can have serious consequences for humans and ecosystems.

13.1. Issues related to stratospheric ozone depletion

Since the 1980s, observations have shown significant seasonal decreases in the stratospheric ozone layer over the Arctic and the Antarctic continent. These declines can reach 50% in late winter and early spring, and are also reflected, to a lesser extent, in mid-latitudes. The thinning of the ozone layer affects the polar regions during the spring.

The depletion of the ozone layer, one of the nine planetary limits (Rockström et al., 2009), is understood by measuring the concentration of stratospheric ozone evaluated in Dobson units (DU). Knowing that the average value of the ozone column is 300 DU, the limit is set at 275 DU, i.e. 95% of its pre-industrial level (290 DU). While this limit was broken in the 1980s, the trends have since reversed, and the average thickness of the ozone layer is gradually increasing. In 2009, the concentration amounted to DU 283. In the 1980s, during the end of the southern winter (September-October), when the sun appeared, the thickness of the ozone layer could approach 100 DU.

13.2. Compounds affecting the ozone layer

Research on the subject has shown that the depletion of the ozone layer follows complex chemical reactions occurring in the stratosphere and mobilizing brominated or chlorinated compounds requiring very low temperatures, reached during polar winters, then significant solar radiation, from the following spring. These compounds are emitted by human activities. The most famous are :

- chlorofluorocarbons (CFCs) used in refrigeration systems, air conditioning, aerosol cans, solvents, etc. ;
- hydrochlorofluorocarbons (HCFCs) developed to replace CFCs due to their shorter lifetime in the atmosphere;
- halons used for extinguishers and fire protection systems;
- carbon tetrachloride used in particular as an industrial cleaning solvent;
- methyl bromide used for the treatment of plants, premises and agricultural soils by fumigation.

13.3. Actions implemented

To preserve the ozone layer and in particular to help restore it, the international community has been committed since 1987 to the Montreal Protocol on Substances that Deplete the Ozone Layer. This international agreement aims to gradually stop the production and consumption of the substances in question. 197 countries have signed this protocol. Since its entry into force, global emissions of these products have fallen by more than 80% and almost all chemicals controlled by the Protocol have been phased out.