

# PERSISTENT POLLUTANTS IN THE POLAR REGIONS

Due to their remoteness, the polar regions remained unspoiled for a long time. Unfortunately, this is no longer the case, because the atmosphere acts like a huge conveyor belt and in the space of just a few weeks, it can transport pollution all over the planet. Polluting gases know no frontiers. Emissions have grown since the dawn of modern industry to reach such an intensity that even regions as far away as the North and South Poles now experience the threat of contamination.

Pollutants include persistent organic pollutants (POPs), acid rain, heavy metals and radioactive isotopes. Some of these pollutants accumulate in the natural environment, contaminating the food chain and becoming more and more concentrated as they make their way up the individual links of the chain and endangering numerous species, from the plankton in the ocean to the great predators.



Figure 1

Atmospheric pollutant transport.

1

The majority of contaminant particles fall close to the sources where they come from in the form of dry deposits.

2

Fine, light particles are carried great distances by the wind (several hundred kilometres or more) before falling back to earth, usually as the result of precipitation (rain or snow).

3 and 4

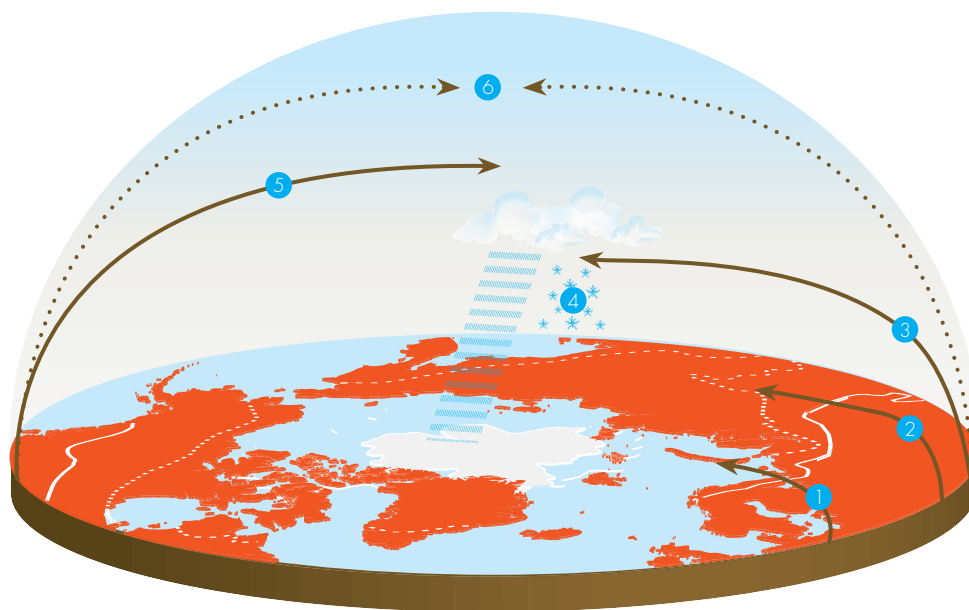
Particles that reach the poles are brought back to earth by local precipitation (usually snowfall).

5

Depending on their density, gases can reach areas much further away: several thousand kilometres from where they were emitted.

6

The lightest and most stable molecules can reach the stratosphere. These molecules include CFCs, which help destroy the ozone layer and also act like greenhouse gases.



## 1) GLOBAL THREAT OF POLLUTION: THE POLAR REGIONS :

As a result of the development of industrial activity, traces of natural and man-made chemical pollution can be found across the entire globe. **Pesticides**, for example are used mainly in agriculture to discourage the pests that attack our fruit and vegetables, as well as to make them look more attractive on the shelves in shops. The widespread use (past and present) of substances such as **organochlorinated compounds**, which are particularly stable and persistent, means that they are found even in the food we eat, sometimes in significant concentrations. This has potential implications for our health.

**DDT** and **PCB**, two well-known organochlorinated compounds, have been detected in the tissue of animals that live in the Arctic or Antarctic all year round. These molecules are ingested at the bottom of the food chain and gradually make their way up, link by link, until they are found at elevated concentrations in the largest predators, such as polar bears and humans.

This phenomenon is called **bioaccumulation** and represents a gradual increase in the concentration of compounds (often toxic), within the food chain. Biologists are now beginning to record the health effects on individuals at the upper end of the food chain, with cases of low fertility, immune deficiency, disruptions to the endocrine system, genetic mutations (**genotoxic effect**) and malformations being seen. These effects may endanger the survival of some polar species

## 2) WHAT ARE THE VARIOUS POLLUTANTS AT THE POLES AND HOW ARE THEY CARRIED THERE?

Among the main threats currently hovering over the poles, the long-distance transport of contaminants from industrial or agricultural areas to the polar regions is of particular concern.

Figure 1 illustrates how pollutants are carried by the atmosphere. In the Arctic, various ice core samples extracted from the Greenland Ice Sheet (GRIP or GISP surveys) or in the far north of Canada (smaller cores) show that the effects of industrial pollution have already been felt for about a century. Today, particles of soot, nitrogen and sulphur dioxide (acid rain), pesticides (PCBs, DDT, etc.), **heavy metals**, radioactive isotopes, etc. can be detected in measurable quantities in the air, snow, sediment and water of the polar regions. This is particularly true in the Arctic, where many pollutants from the northern hemisphere are collected (also as the result of river runoff). Of all the many pollutants released into the environment by human activity, **persistent organic pollutants** (POPs) are among the most dangerous. Used as pesticides and also occurring as by-products from various industrial processes and from combustion, these chemical compounds exist in many forms and can be extremely harmful to the environment and all of the species they come into contact with. Exposure to POPs, especially over the long term, can cause allergies or poisoning, as well as damage to the nervous, endocrine and immune systems, jeopardising the survival of infants and the fertility of adults. Some forms of cancer can



develop if levels exceed certain thresholds. Without doubt the POP with the worst reputation is DDT: this insecticide was used extensively during World War Two to fight a whole range of diseases transmitted by insects, such as typhus and malaria. DDT's stability, persistence and widespread use, especially in developing countries, have all contributed to the fact that residues of the compound are now found as far afield as the polar environment (in penguin fat in Antarctica, for example, or in polar bears in the Arctic). The harmful effects on the eggshells of birds, particularly birds of prey, was highlighted clearly by scientists in the 1970s. This led to strict restrictions on the use of DDT and ultimately to its almost total ban. Despite this, the presence of DDT can still be detected in food all over the world.

PCBs (polychlorinated biphenyls), also POPs, are used to manufacture transformers, condensers, plastics and paint additives. PCBs include about 200 different products, all highly toxic even in low doses. Studies have demonstrated their sterilising [immunosuppressant effects](#) on many species in the animal kingdom including seals and whales in the polar regions.

Because they are highly stable, POPs persist in the environment for several years or even decades. This allows them to circulate across the entire globe via a process called the "[grasshopper effect](#)"- an often seasonal phenomenon in which successive evaporations and deposits enable transportation following atmospheric currents. In the Arctic, for example, pollutants come essentially from two sources: the east and west coasts of North America in winter (big cities and industrial regions) and from central Europe in summer (industry and power stations of the former Soviet Bloc, among others). Antarctica, which is far more isolated than the Arctic, receives most of its POPs during the austral summer when the southerly atmospheric currents resume.

As a result of the [Stockholm Convention](#), several POPs (including DDT and PCBs) are now banned in many countries. However, industry is constantly developing new products, some of which turn out to have properties related to POPs. Brominated flame retardants (BFRs), which are used to prevent the combustion of various plastics, textiles and other materials (e.g. computers, measuring instruments,

etc.) have been shown to be persistent. In Antarctica, high levels of BFRs have been recorded in marine sediment, fish and invertebrates close to the waste water outflow at the American McMurdo base.

### 3) TRANSMISSION OF POLLUTANTS THROUGH THE ARCTIC AND ANTARCTIC FOOD CHAINS :

The ice ecosystems at both the North and South Poles have been particularly affected by POPs that find their way into the food chain through land plants and marine plankton and filtering organisms that absorb the nutrients in the water column. They are then eaten by fish, accumulating in their adipose tissue (fat). POPs are extremely persistent and highly [lipophilic](#), so that they end up becoming concentrated in the adipose tissue of animals higher up the food chain, where they can reach levels up to several tens of thousands of times higher than in the surrounding environment.

POPs climb up the food chain from fish to birds (especially birds of prey) and finally reach the large marine mammals (as well as humans) at the top of the food chain, at increasing concentrations. The traditional diet of Arctic peoples is based on hunting and fishing, which means that the accumulation of POPs and mercury in the food chain has an effect on human health.

Due to their migration, birds also spread POPs that they have ingested throughout the entire land-based ecosystem, sometimes several thousand kilometres from their original source.

Pollution in the Arctic is of particular concern at the top of the food chain, where heavy metals and other pollutants are found in polar bears, belugas, orcas, etc. Scientists from the environmental protection organisation WWF have shown that orcas (killer whales) are now the most polluted predator in the Arctic, having taken over this unenviable position from the polar bear. Orca fat contains significant concentrations of heavy metals, pesticides and other products such as brominated flame retardants. The situation is particularly bad for the polar bear as it also has to cope with habitat changes due to climate change. The animal is now considered endangered.



## GLOSSARY :

**Bioaccumulation or bioconcentration:** n. Ecology. – Accumulation of a chemical substance in the tissue of a living organism at a level higher than in the surrounding environment.

**DDT:** n. Chemistry. – The abbreviation used for Dichloro-Diphenyl-Trichloroethane. This highly toxic organochlorinated insecticide acts on the nervous systems of insects. As it does not biodegrade readily, DDT is passed on to the entire food chain. The use of DDT is banned in most industrialised countries.

**Genotoxic (effect):** adj. Biology. – A chemical substance or physical process likely to modify the genetic code is said to be 'genotoxic'.

**Grasshopper effect:** n. Ecology. – Process by which POPs (see definition below) circulate round the entire planet via the atmosphere. This circulation comes about through a succession of evaporations and deposits (precipitation, usually in the form of snow at the poles).

**Heavy metals:** n. Ecology. – Natural metallic elements with a high density. Some heavy metals, such as mercury, lead and cadmium are toxic for living organisms at certain concentrations (by bioaccumulation).

**Immunosuppressant (effect):** adj. Biology. – Anything that affects the ability of an organism to defend itself against attack (e.g. viruses, bacteria, etc.) by weakening its immune system.

**Lipophilic:** adj. Chemistry. – Chemical substance that has an affinity for fat.

**Organochlorinated compounds:** n. Chemistry. – Hydrocarbons (made up of carbon and hydrogen) that also contain atoms of chlorine or bromine. Most of them are persistent organic pollutants (POPs) that occur in nature or are by-products of combustion or industrial processes. They are used in pharmaceutical products, pesticides, plastics, solvents, etc.

**PCB:** n. Chemistry. – The abbreviation for "Polychlorobiphenyl", a highly toxic organochlorinated insecticide.

**Persistent organic pollutants (POPs):** n. Chemistry. – Organic chemical substances (carbon-based) that are toxic, semi-volatile and difficult to dissolve in water. POPs persist for an extremely long time in the environment (several years) and POPs tend to accumulate in the adipose tissue of living organisms.

## WEB:

See the animations on "Polluting waste: very embarrassing leftovers" and "Emissions linked to the combustion of fossil fuels" at EDUCAPOLES, the educational site of the International Polar Foundation (IPF)

<http://www.educapoles.org>

Other websites containing interesting information related to this subject:

<http://www.amap.no/> (click on "resources and projects" and then "maps and graphics")

<http://www.epa.gov/oia/toxics/pop.htm>

<http://maps.grida.no/index.cfm?event=searchFree&q=arctic+pollutants>

[http://www.arctic.noaa.gov/essay\\_calder.html](http://www.arctic.noaa.gov/essay_calder.html)

<http://www.ec.gc.ca/cleanair-airpur/default.asp?lang=En&n=C0097254-1>

<http://chm.pops.int/Convention/ThePOPs/tabid/673/language/en-US/Default.aspx>

<http://www.arcticpeoples.org/backgrounders/persistent-toxics>