

SCIENCE FOR ENVIRONMENT POLICY

Toxic chemical pollutants: long-range air transport to remote European mountain ranges



17th November 2021
Issue 571

**Subscribe to free
bi-weekly News Alert.**

Source:

Fernandez, P., van Drooge, B., Arellano, L. and Grimalt, J. (2021) Atmospheric deposition of semivolatile organic pollutants in European high mountains: Sources, settling and chemical degradation. *Science of The Total Environment*, 784: 147099.

Contact:

pilar.fernandez@cid.csic.es

Semi-volatile organic chemical pollutants (SOCs) accumulate and persist in the environment, particularly in cold environments such as polar and alpine regions.

These pollutants (SOCs) include previously banned or restricted organochlorine compounds (OCs) such as polychlorinated biphenyls (PCBs), which are manmade chemicals that have been used widely in electrical equipment such as capacitors, as well as in paint, sealants and flame retardants. The semi-volatile nature of these pollutants mean that they can travel long distances by air. This study examines the processes of transport, deposition and degradation of SOC in four alpine European sites.

SOCs are considered toxic, persistent pollutants and include banned or severely restricted organochlorine compounds (OCs) under the [Stockholm Convention](#), such as polychlorobiphenyls (PCBs) (found in paint, sealants and flame retardants), hexachlorobenzene (HCB) (used to kill fungi that affect food crops), hexachlorocyclohexanes (HCHs) (used in insecticides), and polybromodiphenyl ethers (PBDEs) (used as flame retardants). Polycyclic aromatic hydrocarbons (PAHs) share similar properties to OCs and result from incomplete combustion of organic material and from vehicle exhaust fumes. The long-range air transport of these compounds means they can be found globally, far from the emission sources.

As snow is a good receiver of SOC, they are more likely to be deposited in cold temperatures; the elevation of mountains also aids deposition processes of chemical pollutants from the air. This leads to a build-up of the pollutants in cold mountainous areas, which can become secondary sources of SOC pollution if temperature rises trigger their release. Recent evidence suggests that the release of SOC is happening in some polar and alpine regions.

SOC in alpine regions are removed from the air by a number of processes — such as by gas moving diffusively across surfaces, wet deposition (rain, sleet, snow or fog that has become more acidic than normal) and dry deposition (sedimentation of particles during dry periods) and direct/indirect breakdown by sunlight. This study sought to understand the relevance of each of the removal processes, and to identify any influential alpine-specific variables.



SCIENCE FOR ENVIRONMENT POLICY

Toxic chemical pollutants: long-range air transport to remote European mountain ranges (continued)

Read more about:

[Air pollution, Chemicals, Climate change, Environment and health](#)

The contents and views included in Science for Environment Policy are based on independent, peer-reviewed research and do not necessarily reflect the position of the European Commission. Please note that this article is a summary of only one study. Other studies may come to other conclusions.

To cite this article/service:

[“Science for Environment Policy”](#):
European Commission DG
Environment News Alert
Service, edited by
SCU, The University of the
West of England, Bristol.

**[Subscribe to free
bi-weekly News Alert.](#)**

With climate change affecting global temperatures — including those in polar and alpine regions — mountains may become an increasingly important secondary source of SOC pollution. In addition, land-use practices — such as farming in alpine regions — can impact runoff (i.e. snow melting) thereby increasing the release of SOC into the air. The researchers suggest that understanding the sources of alpine SOC, and alpine deposition and revolatilisation processes (turning from a solid or liquid into a vapour) — may enable policymakers to design effective environmental SOC-reducing policies.

Samples of both wet (rain/snow) and dry (on surface of snow/soil/vegetation) deposits from the air were collected from four high European lakes: Skalnaté Pleso (Tatra mountains, Slovakia), Gossenköllesee (Alps, Austria), Redon (Pyrenees, Spain), and Lochnagar (Grampian Mountains, Scotland). The samples, collected between 2004 and 2007, were analysed for PAHs and OCs using gas chromatography and mass spectrometry (an analytical technique used to separate chemical components of a sample mixture and detect them to determine their presence or absence and/or quantity). A meteorological model was used to calculate air mass origin from six hours before — on days when there was precipitation or snow, and every two days when there was no precipitation.

A statistical method was used to identify correlations between atmospheric deposition of pollutants and environmental variables — temperature, precipitation, particle deposition, sampling site characteristics and prevailing backward air mass trajectories (used to investigate air-mass flow around mountains).

PCBs, HCHs and low-brominated BDEs (which more efficiently bioaccumulate) had baseline contributions (the average of data entries calculated by totalling the numbers and dividing the sum by the number of entries) from long-range atmospheric transport. A long-range air transport baseline was also established for PAHs in Redon and Gossenköllesee lakes, endosulfans (organochlorine insecticides that are no longer in use) in Lochnagar and Gossenköllesee lakes, and for HCB in all three lakes.

All compounds were found at the highest levels in Skalnaté, the eastern site, where PAHs, endosulfans and HCB from regional sources were also located. Endosulfans from regional sources were found in Redon. The origin of the pollutants was determined by the relative composition of some chemicals. In samples from Lochnagar, Scotland, for example, low-brominated BDEs were found to come from north America.



SCIENCE FOR ENVIRONMENT POLICY

Toxic chemical pollutants: long-range air transport to remote European mountain ranges (continued)

The researchers found that wet deposition was the main process for removal of PAHs, HCHs, and HCB from the air. Volatile PAHs, HCB, low-chlorinated PCBs and endosulfans were prone to warm-season revolatilisation from soils and melting snow, with subsequent condensation at low temperatures. Photolysis was the main process of removal of PBDEs at all sites, with this process also influencing PAH removal.

Understanding the sources of SOC_s found in European alpine environments and the processes leading to removal of these pollutants from the air helps inform adequate design of regulatory measures to reduce environmental concentrations, the researchers suggest. They note, however, that as primary emission sources of SOC_s decrease — due to legislation — revolatilisation of deposited SOC_s in alpine and other regions is likely to become a relatively greater global source of these pollutants.