Update on current initiatives for a more structured sample and data collection of environmental contamination in the Antarctic

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**Information Paper submitted by Germany, Italy, Australia, United Kingdom, United States of America and Sweden**

Summary

There is growing evidence that the Antarctic is increasingly exposed to chemical stressors. Antarctica is impacted by global issues such as climate change and long-range transport of chemicals. Furthermore, expanding tourism and research activities (including logistical activities serving their conduct or preparation) can affect the pristine environment. To date, there is a lack of systematic approaches and data to study and assess chemical pollution of the Antarctic environment and to derive knowledge-based measures for its protection.

In particular, synergies between the Environmental Specimen Banks (ESBs) and National Antarctic Programs (NAPs) can be a straightforward way to guarantee that current and future monitoring actions will be representative and continuous, procedures will be harmonized, quality control of the analytical data will be established, and that future generations will be offered the opportunity for retrospective studies. A systematic and efficient sample and data collection plan should also improve the effective use of scientific information, accelerate decision-making for environmental protection measures and, consequently, promote the future conservation of the Antarctic environment and its dependent and associated ecosystems.

The purpose of this paper is to outline the progress that has been made in establishing an international network – following ATCM XLIII/IP021 submitted by Germany and Italy – aimed at promoting and coordinating a more structured sample and data collection of environmental contamination in the Antarctic. This paper follows the discussion at the Expert Workshop ‘Act now – Legacy and Emerging Contaminants in Polar Regions’ co-hosted by the *German Environment Agency* (UBA) and the *Institute of Coastal Environmental Chemistry, Helmholtz-Zentrum Hereon* (Geesthacht, Germany) in January 2022. In order to have a sufficiently comprehensive and up to date data basis for this workshop and further work, UBA has commissioned a report to review studies on the occurrence of emerging organic contaminants (EOCs) in both the Arctic and the Antarctic and to evaluate the long-range environmental transport processes of EOCs via ocean currents and the atmosphere from continental sources to polar regions.

Background

Antarctica is one of the planet’s last wildernesses, designated by the Antarctic Treaty in 1959 as a ‘natural reserve, devoted to peace and science’. In 1991, the Protocol on Environmental Protection to the Antarctic Treaty (the Protocol) enshrined the protection of the Antarctic environment because of its intrinsic value and its importance as an area for scientific exploration, in particular research essential to understanding the global environment.

Nevertheless, serious threats to the conservation of the Antarctic environment do exist, including chemical contamination related to various sources, such as research stations, scientific activities, tourism and fishing operations, vessels incidents, and long-range transport of legacy pollutants and contaminants of emerging concern (CEC) from mid-latitudes. As a result, the presence of persistent organic pollutants (POPs) and trace elements have been detected in Antarctica (ATCM XXXI/IP097, ATCM XXXII/IP069, ATCM XXXVII/IP008, ATCMXL/IP022). Furthermore, emerging contaminants (e.g. flame retardants, pharmaceuticals and personal care products, microplastics) can be found in Antarctica (Waller et al., 2017, Vecchiato et al. 2017, Dreyer et al. 2019,), although environmental monitoring activities are still scarce in comparison to data from the Northern Hemisphere. It is therefore not surprising that the assessment of chemical contamination is becoming an important topic of various research programs in Antarctica, including the Italian National Antarctic Research Programme (PNRA), launched in 1985 and arrived today at its 37th year of activity.

ESBs systematically archive samples from the environment for future research and monitoring purposes (Küster et al. 2014). In addition, the long-term preservation of representative specimens is an important complement to environmental research and monitoring plans. The first banking activities were set up in the 1960s in Sweden and Japan and then in the 1970s and 1980s in the USA and in Germany, respectively. Today, around 30 national ESBs are established around the globe, including the *Italian Antarctic ESB* (BCAA), operating since 1994 within the PNRA (Soggia et al. 2001). UBA, to which the German ESB belongs, has initiated case studies together with the *Alfred-Wegener-Institute, Helmholtz-Zentrum für Polar- und Meeresforschung* (AWI) to explore the use of samples from penguin colonies, coastal fish and krill for contaminant analysis, including systematic archiving. Moreover, UBA will commission a research project with funding from the Federal Ministry for the Environment, Nature Conservation, Nuclear Safety and Consumer Protection to develop more detailed ideas about systematic approaches to gathering data and information about the chemical pollution and its impacts on the Antarctic environment. The aim is to derive knowledge-based measures for protecting the Antarctic environment.

The SCAR ImPACT (Input Pathways of Persistent Organic Pollutants in Antarctica) Action Group was established in 2018 to facilitate coordinated investigation and monitoring of chemical inputs into the Antarctic. Through ATCMXLIII/IP137, the Action Group has identified priority challenges for persistent organic chemical research in Antarctica. The paper includes the identified priority research gaps and proposed actions that resulted from a scoping meeting of the group. It identified potential approaches for coordinated research and monitoring efforts and outlined a set of actions needed to align research on persistent organic chemicals in the Antarctic with international efforts and existing global monitoring frameworks.

Findings within the project ‘Emerging and legacy organic contaminants in the polar regions’

The aim of the project ‘Emerging and legacy organic contaminants in the polar regions’, funded by UBA, was to review studies on the occurrence of EOCs in both the Arctic and the Antarctic and to evaluate the long-range environmental transport processes of EOCs via ocean currents and the atmosphere from continental sources to polar regions.

The report indicates that legacy POPs in environmental media and biota decline in both the Arctic and the Antarctic in response to regional and international chemical management, e.g. the Stockholm Convention. It has been observed, that reemission of POPs that previously accumulated in polar environment can enter the global cycle again following ice retreat, glacier melting and permafrost throwing due to global warming. On the other hand, a number of CECs has been reported in different environmental media in the Arctic and Antarctic. Literature data showed that environmental pathways such as atmospheric deposition, air-water exchange and discharge from seasonal melting can interfere with the biogeochemical cycling of CECs in polar regions. Local emissions of certain CECs may occur near research stations, harbours and tourism sites. Some EOCs such as per- and polyfluoroalkyl substances (PFASs), chlorinated paraffins (SCCPs and MCCPs) and organophosphate esters (OPEs) have been included in long-term atmospheric monitoring programs of the Arctic Monitoring and Assessment Programme (AMAP). Screening survey for EOCs in environmental and biological matrices have been carried out through national and regional research programs. Data of CECs in Antarctic are scarce. Nevertheless, the long-range environmental transport of CECs has been highlighted with their occurrences in the ice core, snow and lake waters in polar regions.

The major findings for ten groups of CECs are presented in detail in the [UBA-Texte report “Emerging and legacy organic contaminants in the polar regions”](https://www.umweltbundesamt.de/publikationen/emerging-legacy-organic-contaminants-in-the-polar)as well as in the related [publication “Legacy and emerging organic contaminants in the polar regions”](https://doi.org/10.1016/j.scitotenv.2022.155376).

Outcomes of the Expert Workshop ‘Act now – Legacy and Emerging Contaminants in Polar Regions’

On 25 and 26 January 2022, experts from four continents met online at the Expert Workshop ‘Act now – Legacy and Emerging Contaminants in Polar Regions’ co-hosted by UBA and the *Helmholtz-Zentrum Hereon* and discussed potential impacts of legacy and new hazardous chemicals, which accumulate in snow, ice and wildlife. It was the first time that international experts from contaminant research in polar regions, representatives from regulatory chemical assessment and monitoring, ESBs, and information and data platforms jointly discussed pressing chemical pollution issues in the polar regions and opportunities for collaboration. The goal of the workshop was to provide recommendations for improving screening, monitoring, assessment, co-operation and data sharing to provide environmental policy and chemicals management with effective and reliable pollution data to protect the polar environment. Members of the European Commission, the Stockholm Convention, the Arctic Council, the Antarctic Treaty Consultative Meeting, ESBs and Data Centres discussed together with the research community two questions which were a common thread throughout the workshop: What are the common goals and scientific bases for chemical research and monitoring in the polar regions - and how do the respective approaches differ for the Arctic and Antarctic?

The overarching outcome of the discussion during this Expert Workshop is the need for more structured sample and data collection of chemical contamination in Antarctica, through the establishment of an international network, which brings together all relevant actors and stakeholders, including the national research programs in Antarctica, the ESBs and policy makers. While arctic-wide assessments have already been prepared through the *Arctic Monitoring and Assessment Programme* (AMAP) within the Arctic Council, such assessments are still missing in the Antarctic. The ATCM together with the *Scientific Committee of Antarctic Research* (SCAR ImPACT Action Group), the NAPs and Environmental Agencies could use the proven frameworks and structures by AMAP to strengthen their efforts to initiate a more structured sample and data collection of environmental contamination in the Antarctic. The Protocol and the work of the CEP together with a better understanding of the current state of the Antarctic environment and of the long-term effects of persistent contaminants on the organisms and food chains, would enable the Antarctic Treaty Parties to make necessary decisions or to take measures for the protection of the Antarctic environment, wherever needed and to distinguish local from global sources.

As a result of the workshop, the following strategic and technical recommendations for contaminant research and monitoring in polar regions were developed:

“Strategic recommendations:

* Raise awareness among policymakers and the public about the need to take better action against chemical pollution in the Arctic and Antarctic,
* Set up a network of all relevant actors and stakeholders, including policy makers, regulators, the research community, non-governmental organisations, indigenous communities and the public,
* promote polar environments as sentinels of the Earth's condition and forcefully present their importance to the concepts of planetary boundaries and the EU's goal of zero pollution ambition,
* define stakeholder needs and make systematic use of polar pollution data in regional and international chemicals management,
* develop long-term perspectives for standardized monitoring: establish chemical monitoring capacities and expertise in the Antarctic and strengthen existing infrastructure in the Arctic,
* support systematic environmental specimen banking to help monitor temporal trends, support environmental research and provide samples for future generations,
* foster data repositories according to the FAIR data principles[[1]](#footnote-1) so that all polar contaminant data are findable, accessible, interoperable and reusable, and link to other data bases, e.g. EU IPCHEM, the Norman network.

Technical recommendations:

* Establish harmonised workflows for collecting, shipping, processing, and archiving of environmental samples, and their chemical analysis,
* connect monitoring approaches for long-range transport of pollutants and the local chemical footprint from tourism, research, and settlements,
* integrate state-of-the-art chemical analysis methods, including mass spectrometry and effects directed analysis to monitor contaminants of emerging concern together with legacy pollutants,
* link to innovative prioritisation and screening approaches and explore advanced modelling approaches for chemicals in the environment,
* explore the use of innovative monitoring tools, such as passive samplers, in extreme environments like the Antarctic where operations and logistics are challenging,
* generate data for POPs and CECs in the Russian part of the Arctic to enable a more comprehensive circumpolar view and to investigate large-scale spatial and temporal trends.”

The workshop report including the proceedings, abstracts of presentations and the reports of the working groups can be downloaded: <https://www.umweltbundesamt.de/en/node/94089%20>.

Conclusions

Organic contaminants in polar regions have become significant concerns because of their persistence, bioaccumulation and toxicity potential. Climate change can alter the biogeochemical cycling of POPs and CECs and amplify their effects on polar ecosystems. Occurrences of POPs and CECs from long-range transport and local discharge have left impacts on these fragile regions. Therefore, actions are urgently needed to monitor the temporal trends of POPs and to strengthen research of CECs in the Antarctic through national and international research programs. Glacial ice and snow have acted as secondary emission sources in the polar regions and released POPs and CECs into the atmosphere and ocean. Future research will need to understand the various biogeochemical and geophysical processes under climate change and anthropogenic pressures to be able to predict the environmental fates and the toxicity risk of CECs in polar regions.

The cooperation between national research programs of Antarctic Treaty Parties and ESBs is considered the easiest and most effective way towards a more structured sample and data collection on chemical contamination in the Antarctic, corresponding with the requirements of the Protocol.

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1. The FAIR Data Principles are a set of guiding principles in order to make data findable, accessible, interoperable and reusable (Wilkinson et al., 2016. The FAIR Guiding Principles for scientific data management and stewardship) [↑](#footnote-ref-1)