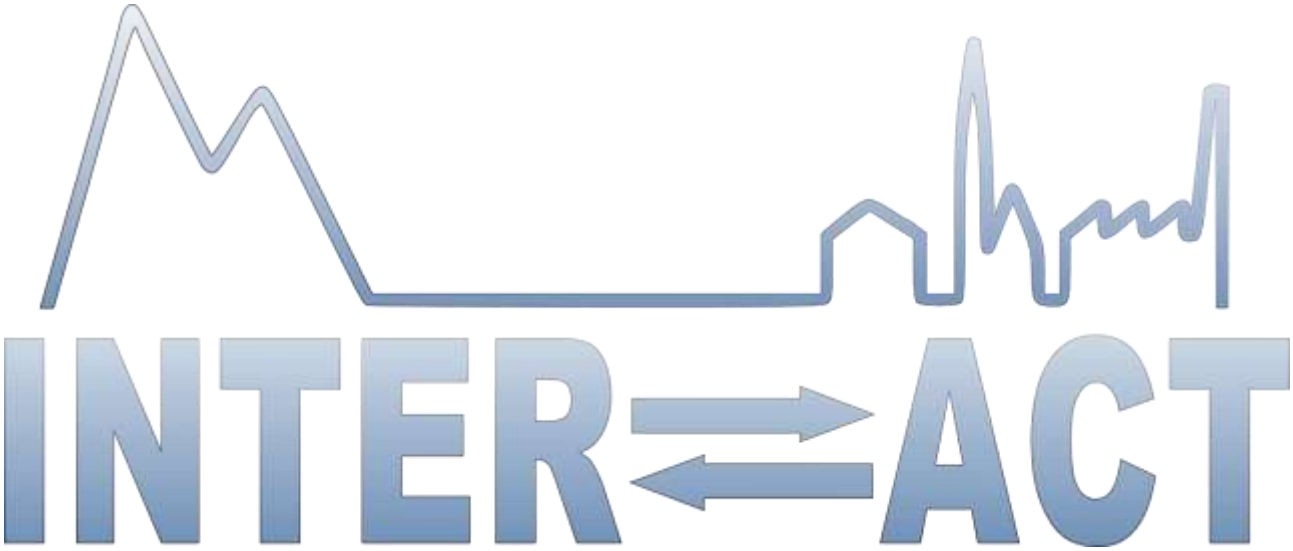
Integrating Activities for Advanced Communities



D8.3 – Testing of protocols with Managers at selected INTERACT stations

Project No.871120– INTERACT

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Start date of project: 2020/01/01 Duration: 48 months
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Lead partner for deliverable: AMAP-SEC
Author: Simon Wilson

Dissemination Level		
PU	Public	X
PP	Restricted to other programme participants (including the Commission Services)	
RE	Restricted to a group specified by the Consortium (including the Commission Services)	
CO	Confidential, only for members of the Consortium (including the Commission Services)	

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Publishable Executive Summary

Over the past three decades, and based on increasing research and monitoring effort, bodies such as the Arctic Monitoring and Assessment Programme (AMAP) have documented the presence and effects of (chemical) environmental contaminants in the Arctic. This information has been used to inform policy- and decision-making at the national and international level aimed at reducing and where possible eliminating the sources of such contaminants.

The 2017 AMAP assessment Chemicals of Emerging Arctic Concern (CEACs) documented the presence in Arctic environmental media of a number of 'new' chemicals/groups of chemicals. Some of these CEACs have been introduced to replace banned substances, many lack information concerning their properties and possible toxic effects, and many are challenging to analyse. Some CEACs will reach the Arctic due to long-range transport, others are associated with consumer products that may be used in Arctic communities and therefore enter waste streams in the Arctic. CEACs may also have sources associated with industrial development in the Arctic, or even research activities themselves.

The Arctic is undergoing unprecedented change, primarily associated with climate warming from emissions of greenhouse gasses and short-lived climate forcers. Surface air temperatures in the Arctic have increased at three times the global average over the past 50 years, resulting in cryosphere change (loss of sea- and land ice, permafrost thaw, etc.) and changes to Arctic ecosystems. Related to these environmental changes are improved access, in particular marine access, to areas that are potentially rich in natural resources. Human development of the Arctic has increased, and this trend is expected to continue. With increasing human presence in the Arctic comes increasing use of chemicals within the region. Climate change is also altering pathways and fate of environmental contaminants, potentially remobilizing contaminants that have accumulated in Arctic snow, ice, water, and sediments as well as altering their uptake and transfer through Arctic ecosystems and food webs.

Under INTERACT WP8, work has identified chemicals that could be considered for a coordinated research/monitoring effort involving the Arctic research station network, their scientific research community, and associated local communities (D8.1) and options for practical work that could be implemented at INTERACT stations to support environmental contaminants monitoring and research (D8.2).

This deliverable builds on that earlier work to examine options for practical work that could be implemented at INTERACT stations to support environmental contaminants monitoring and research. It relates specifically to the task of *'testing the protocols developed to enhance screening monitoring applications at INTERACT Stations, and where possible linking this to ongoing screening monitoring programs and networks'*. It presents the outcome of a workshop arranged to promote monitoring at INTERACT stations based on deployment of passive samplers, and the status of subsequent follow-up activities.

1. Purpose and scope of this document

The INTERACT station network provides an opportunity for enhancing research to better understand the occurrence and sources of contaminants such as Persistent Organic Pollutants (POPs) and Chemicals of Emerging Arctic Concern (CEACs), including increasing engagement of INTERACT stations in monitoring programmes such as that coordinated by the Arctic Monitoring and Assessment Programme (AMAP).

Previous INTERACT III WP8 deliverable identified chemicals of potential interest in this context (D8.1) and options for practical work that could be implemented at INTERACT stations to support environmental contaminants monitoring and research (D8.2). Several of the proposed options involve the potential use of passive samplers at the stations, reflecting both the utility of this approach and the practical limitations on the level of resources that can readily be identified within existing station operational settings to support such pilot implementation work.

Deliverable 8.2 describes three possible approaches for implementing pilot monitoring/screening of contaminants at INTERACT stations based on (1) Passive air sampling, (2) Passive water sampling and (3) Collection of environmental media (biota, snow), identifying some of the advantages, disadvantages and requirements associated with these respective approaches. Some INTERACT stations operate passive samplers as part of national and in a few cases international monitoring programmes, but considerable potential exists for extension of this work to other stations.

This document reports on progress under Task 8.3 (*Enhancing screening monitoring applications at INTERACT Stations)* regarding uptake of the options presented in D8.2, specifically progress in '*Implementing and/or testing the protocols developed, and where possible linking this work into ongoing screening monitoring programs and networks'.*

It should be noted that work under Task 8.3 has been impacted both by the Covid pandemic and the restrictions introduced following the Russian invasion of Ukraine. A WP8-convened workshop originally scheduled for May 2022, could not be realised, and was therefore postponed. Consequently opportunities to implement pilot monitoring/screening work during the summer 2022 field season were restricted.

This deliverable reports on the outcomes of the rearranged workshop, which was held in December 2022, and follow-up activities planned during the remainder of the INTERACT III project period. Collaborations have been instituted between passive sampler network operators and several INTERACT stations with good expectations that pilot contaminant monitoring implementation work will be at several sites in 2023.

2. Results of Work to Date

2.1. Test deployment of PWS on Greenland

Referring to the options presented in deliverable D8.2, scientists involved in AMAP's Greenlandic monitoring programme issued a request in March 2022 to INTERACT stations on Greenland for possible assistance in deploying a PWS in a marine setting. The INTERACT Greenland Institute for Natural Resources (GINR) station assisted in deploying a PWS in Kobberfjord over the summer of 2022. Unfortunately, the deployed sampler was subject to accidental or intentional interference and could not be recovered. While disappointing from the perspective of obtaining information on environmental contaminants in the Kobberfjord, the experience gained in this exercise is informative to the general work to encourage use of PS at INTERACT stations. Firstly, constructing the sampler on-site from instructions provided proved difficult. Resulting feedback to the principle scientist will improve the instructions for any future deployment, but raise a general point regarding need for adequate instructions to station managers/field operators, including practical testing of this guidance/instructions by those who are responsible for the work prior to actual field work to install the PS. Secondly, damage to PS equipment following deployment has been reported at a number of Arctic sites where PS are deployed, both concerning PAS and PWS. This may be related to casual vandalism (e.g. using PAS for target practise) or simple curiosity (mistaking PWS for fishing gear, etc.). Again, this type of practical problem should be anticipated and measures taken, to the extent possible, to reduce the risk of such damage.

2.2. Workshop between INTERACT station-managers and PS network operators

To develop the proposals and options for pilot implementation of contaminants monitoring at INTERACT stations, a (hybrid) WP8 workshop was arranged (7 December 2022) with assistance of the INTERACT station-managers forum (WP2). The workshop was convened as a side-event to the ArcticNet Arctic Science Conference in Toronto, Canada.

The main aim of the meeting was to facilitate connections between coordinators of passive sampler networks and INTERACT stations. The workshop attracted ca. 30 participants representing:

- 5 passive sampler communities :
    - AQUA GAPS/MONET
    - GAPS
    - NORMAN (air)
    - PARC
    - National experts involved in PS work (Canada, Greenland)
- 19 INTERACT Stations directly, and 4 stations indirectly (see Figure 1).

The report of the workshop, including notes on presentations and subsequent discussions, is attached as Appendix 1.

Figure 1. INTERACT sites represented at Workshop

2.3.Post workshop follow-up activities

Table 1, below, summarizes the interest in possible follow-up with the passive sampler networks as indicated by workshop participants, either during the workshop or subsequently, together with relevant site information. For additional information on station facilities, research activities and access, etc., the station names link to respective entries in the INTERACT III project GIS.

Contact points for the respective passive sampler networks, and further information on presentations on the work of these networks is included in the workshop report (see Appendix 1).

At the point of preparing this deliverable, plans for follow-up activities are as described in the sections below.

Table 1: INTERACT station interest in possible follow-up with the passive sampler networks (grey cells: no information).

INTERACT Station	Existing PAS deployment	Existing PWS deployment	Interest in PAS deployment	Interest in PWS deployment	Site information
Abisko			√	√	**Country:** Sweden **Climate zone:** Located in mountain birch forest, approx. 380 m.a.s.l., near the shore of Lake Torneträsk. Surrounded by birch forests, mires, freshwater bodies, mountains and alpine tundra. 68°N. **Operational period:** Year-round operation, permanent staff. **Nearest town/settlement:** Located near the village of Abisko (~150 permanent inhabitants, many seasonal tourists). Station located near paved road (approx. 125m; Luleå-Narvik, E10, speed limit 90 km/h, passenger vehicles and trucks) and railroad (approx. 150m; four passenger trains per day and 10+ iron ore trains per day). **Contact point:** Emily Pickering Pedersen <emily.pedersen@polar.se> **Other:** Long-term environmental monitoring programme on-site, focusing on meteorological measurements. Potential to have passive air and/or water samplers deployed in connection to the already-existing environmental monitoring programmes.

INTERACT Station	Existing PAS deployment	Existing PWS deployment	Interest in PAS deployment	Interest in PWS deployment	Site information
Arctic DTU Research Station					**Country:** Greenland **Climate zone:** Situated between sea, mountains, tundra and ice. The landscape around the station is the largest ice free area in Greenland. **Operational period:** Manned year round **Nearest town/settlement:** The station is situated in Sisimiut, the second largest town of Greenland with app. 5500 inhabitants. **Contact point:** Steffen Ringsø <steffen.r.nielsen@gmail.com> **Other:** Logistical support (4WD cars, snowmobile, ATV, equipment and charter of boat), field storage, laboratory access can be arranged.
Arctic Station			√	√	**Country:** Greenland **Climate zone:** **Operational period:** Year-round operation, permanent staff. **Nearest town/settlement:** Located near the village Qeqertarsuaq (~850 inhabitants) on Disko Island, central West Greenland. Transport to Disko from Ilulissat or Aasiaat; by boat during summer (May-October) and by helicopter during winter (Nov-May). **Contact point:** Charlotte Sigsgaard <cs@ign.ku.dk> **Other:** Connections to local community; access to boats for marine deployment. Arctic Station is part of Greenland Ecosystem monitoring (GEM) and is running a long-term monitoring programme covering both Marine and Terrestrial activities (www.g-e-m.dk). Potential to have both PAS and PWS installed. There are sensors deployed in the river Røde Elv each year and there are a lake nearby (Moræne sø) for potential lake deployment. See INTERACT Station catalogue for more info about Arctic Station (27). There are laboratory facilities at Arctic Station. Shipping of equipment; air freight ~1 week, sea freight~4 weeks.

INTERACT Station	Existing PAS deployment	Existing PWS deployment	Interest in PAS deployment	Interest in PWS deployment	Site information
CEN – Whapmagoostui-Kuujjuarapik			√	√	**Country:** Canada **Climate zone:** Located at the terrestrial boundary between taiga and tundra; discontinuous or scattered permafrost occurs throughout the region and is degrading rapidly; climate is strongly influenced by the proximity of Hudson Bay, and the recent pronounced loss of sea ice has been accompanied by large increases in air temperature **Operational period:** Year-round operation **Nearest town/settlement:** The station is located on the eastern shore of Hudson Bay at the maritime limit of James Bay, and in the adjacent villages of Whapmagoostui (Cree First Nation) and Kuujjuarapik (Inuit). **Contact point:** Mickael Lemay <mickael.lemay@cen.ulaval.ca> **Other:** Interest of CEN to deploy PAS at Whapmagoostui-Kuujjuarapik; could maybe install 2 PAS, one in the station vicinity (probably recording the influence of the diesel electric central) and one outside the community in the natural environment (far from direct sources of contamination). Station has good connection with local community; access is by commercial airlines; access to the surrounding area by chartered flights, boat, and all-terrain vehicles can be arranged

INTERACT Station	Existing PAS deployment	Existing PWS deployment	Interest in PAS deployment	Interest in PWS deployment	Site information
CEN – Kangiqsuallujjuak			√	√	**Country:** Canada **Climate zone:** The area is characterized with discontinuous permafrost. **Operational period:** Open year-round **Nearest town/settlement:** The station is located directly within the limits of the village of Kangiqsualujjuaq which has a population of 942 inhabitants. **Contact point:** Mickael Lemay <mickael.lemay@cen.ulaval.ca> **Other:** Interest of CEN to deploy PAS at Kangiqsuallujjuak (Nunavik); could maybe install 2 pAS, one in the station vicinity (probably recording the influence of the diesel electric central) and one outside the community in the natural environment (far from direct sources of contamination). Station has good connection with local community; daily access by commercial airline (Air Inuit) from Kuujjuaq
CEN – Other possible sites (Bylot Island, Umiujaq, Salluit and Clearwater Lake)			√	√	**Country:** Canada **Climate zone:** see links **Operational period:** see links **Nearest town/settlement:** see links **Contact point:** Mickael Lemay <mickael.lemay@cen.ulaval.ca> **Other:** If deployment at CEN - Whapmagoostui-Kuujjuarapik and/or CEN - Kangiqsuallujjuak prove successful, could consider more remote sites like Bylot Island next year, with an irregular sampling frequency of the PAS (e.g. from August/September to May/June (winter) and from May/June to August/September (summer)). Other possible sites would be Umiujaq, Salluit and Clearwater Lake

INTERACT Station	Existing PAS deployment	Existing PWS deployment	Interest in PAS deployment	Interest in PWS deployment	Site information
GINR			√	√	**Country:** Greenland **Climate zone:** Low Arctic ecosystem (Nuuk and the Kobbefjord) with different biotopes such as dwarf-shrub heaths, fens, grasslands, and lakes. Niaqornat, Uummannaq is at the border between Low and High Arctic. **Operational period:** Year-round operation (Nuuk), satellite stations – seasonal. **Nearest town/settlement:** Main facilities are located in Nuuk (ca 16 000 inhabitants); additional facilities include field stations in Kobbefjord and Niaqornat (ca. 70 inhabitants) close to Uummannaq. Access via commercial flights to Nuuk; transportation to Kobbefjord is by one of GINR's own smaller boats carrying up to 12 persons. The field station in Niaqornat can be reached twice a week by helicopter from Uummannaq. **Contact point:** Katrine Raundrup <kara@natur.gl> **Other:** GINR has potential interest in deployment of GAPS PAS and the freshwater passive samplers
Oulanka			√		**Country:** Finland **Climate zone:** taiga, north boreal **Operational period:** Year-round operation **Nearest town/settlement:** Station is nearly on the Arctic Circle, close to the border with Russia, in a national park; nearest village is 13 km away; ski centre of Ruka 30 km away; Kuusamo 55 km; otherwise in area of sparse population **Contact point:** Riku Paavola <Riku.Paavola@oulu.fi> **Other:** Oulanka research station potentially interested in hosting a passive sampler

INTERACT Station	Existing PAS deployment	Existing PWS deployment	Interest in PAS deployment	Interest in PWS deployment	Site information
Petunia Bay (Svalbard)				√	**Country:** Svalbard **Climate zone:** High Arctic tundra, in zone of continuous permafrost. **Operational period:** **Nearest town/settlement:** Pyramiden harbour (4 km from the station; tourist ships in summer season); Longyearbyen, 60 km away; station located on the western coast of Petunia Bay (Petuniabukta) in NE part of Isfjorden, central Spitsbergen. In the vicinity of former Russian coal mine Pyramiden, abandoned in 1998, now operating for tourism. Access via Longyearbyen (air) and Pyramiden (ship) and on foot from harbour or using zodiac boats for transportation within the fiord. **Contact point:** Juliana Kasprzyk <Juliana.souza-kasprzyk@amu.edu.pl> **Other:** Interest in AQUA-GAPS/MONET PWS network, with possibility to send the samplers between Poland and Czech.
Qaanaaq (DMI Geophysical Observatory)					**Country:** Greenland **Climate zone:** Cold, dry, tundra climate with running water only during four months of the year. Peninsula is covered by a small local ice cap. City based on permafrost and the fjord is covered by land fast ice from December through June. **Operational period:** Station open year-round **Nearest town/settlement:** Station is located at the outer perimeter of the city of Qaanaaq in North West Greenland. Qaanaaq has weekly connecting flights from Ilulissat. Local transport is mainly by small boats in summer and dog sleds during winter. **Contact point:** Steffen M. Olsen <smo@dmi.dk> **Other:**

INTERACT Station	Existing PAS deployment	Existing PWS deployment	Interest in PAS deployment	Interest in PWS deployment	Site information
RIF Field Station					**Country:** Iceland **Climate zone:** Maritime Low/Subarctic, open coastal area highly exposed to the cold northerly winds. Coast characterized by sloping gravel banks, numerous open and land-locked bays, inlets, salt marshes and brackish lagoons which communicate with freshwater lakes. **Operational period:** - **Nearest town/settlement:** Station is located in Raufarhöfn, a small village on the northeast coast of Melrakkaslétta peninsula in Northeast Iceland. Accessible by car; nearest domestic airports are at Þórshöfn (67 km), Húsavík (130 km) and Akureyri (222 km). **Contact point:** Pedro Rodrigues <pedro@rifresearch.is> **Other:** If interest in deploying passive samplers at site on Azores, contact point can also facilitate relevant contacts at University of the Azores.
Sermilik Research Station					**Country:** Greenland **Climate zone:** Low arctic coastal zone **Operational period:** Year-round operations **Nearest town/settlement:** The station is located in southeast Greenland, about 20 km north of the small town Tasiilaq (Ammassalik) on the shore of the Sermilik Fjord. Access by boat or helicopter charter. **Contact point:** **Other:**

INTERACT Station	Existing PAS deployment	Existing PWS deployment	Interest in PAS deployment	Interest in PWS deployment	Site information
Sodankylä			√		**Country:** Finland **Climate zone:** Boreal forest. **Operational period:** Year-round operation **Nearest town/settlement:** The Pallas-Sodankylä facilities are located in western and central Lapland in a national park, with limited access. The distance between the two sites is 125 km **Contact point:** Anna Kontu <anna.kontu@fmi.fi> **Other:** Clean air research station (Pallas); A possible PAS deployment at Sodankylä would be of interest.
Sonneblik	√				**Country:** Austria **Climate zone:** Alpine **Operational period:** Year-round **Nearest town/settlement:** Sonnblick Observatory is located in the Austrian Central Alps at an elevation of 3106 m a.s.l. at top of the mountain. Nearest villages are Heiligenblut (10 km) and Rauris (20 km). **Contact point:** **Other:**

INTERACT Station	Existing PAS deployment	Existing PWS deployment	Interest in PAS deployment	Interest in PWS deployment	Site information
Sudurnes SLC			√	√	**Country:** Iceland **Climate zone:** Maritime subarctic **Operational period:** Year-round operation **Nearest town/settlement:** Sudurnes Science and Learning Center is located by Sandgerdi (ca. 1600 inhabitants) harbor on the western coast of the Reykjanes Peninsula, about 50 km west of the capital, Reykjavik. Accessible by car/public transport. **Contact point:** Sölvi Rúnar Vignisson <solvi@thekkingarsetur.is> **Other:** It would be possible for the centre to arrange for installation of PAS on Iceland in an area with no human contact (one site on Iceland already contributes to the GAPs network); deployment of PWS in lake settings (large/small lake, close to population or remote) would also be possible; deployment of a PWS in marine system would require funding but station has access to boat and suitable setup for this.
Tarfala Research Station TRS			√	√	**Country:** Sweden **Climate zone:** High alpine-subarctic **Operational period:** Open in April and June-September **Nearest town/settlement:** Located at 1130 m asl. in the Kebnekaise Mountains, 24 km from the nearest settlement (the Sami village Nikkaluokta). **Contact point:** Annika Granebeck <annika.granebeck@su.se> **Other:** Situated above the tree line, in the area of Laevas Same village, east of Kebnekaise, among Sweden's highest mountains, several glaciers, the arctic alpine Lake Tarfala and surrounded by blockfield terrain. Access by hiking, snowmobile or helicopter. Long-term observations of watercourses and ecosystems, and study of the changing state of glaciers. Ongoing monitoring of Tarfala lake and Tarfala jokk with potential to have PAS and PWS (jokk and lake) deployed.

INTERACT Station	Existing PAS deployment	Existing PWS deployment	Interest in PAS deployment	Interest in PWS deployment	Site information
Toolik Field Station	√			√	**Country:** United States **Climate zone:** Tundra, continuous permafrost **Operational period:** Year-round operation **Nearest town/settlement:** Located, to north of Gates of Alaska national park, 210 km from Deadhorse and 600 km north of Fairbanks, Accessible by road; station provides transportation to/from these towns, and snowmobiles, boats, trucks, and bicycles for local transportation. Closest native village is Anaktuvuk in the Brooks Range ca. 150 km west of the station. **Contact point:** Syndonia Bret-Harte <msbretharte@alaska.edu> **Other:** Potential for adding freshwater lake PWS deployment to existing PAS. Toolik will continue to offer remote access after INTERACT ends.
UKCEH Cairngorms				√	**Country:** United Kingdom **Climate zone:** Rural, north boreal **Operational period:** - **Nearest town/settlement:** Located in national park close to Aviemore ski resort (population ca. 2500) **Contact point:** Jan Dick <jand@ceh.ac.uk>; Christopher Andrews <chan@ceh.ac.uk> **Other:** UKCEH station has long-term environmental monitoring programme, with interest in being part of networks.

INTERACT Station	Existing PAS deployment	Existing PWS deployment	Interest in PAS deployment	Interest in PWS deployment	Site information
Utqiaġvik			√		**Country:** United States **Climate zone:** Polar maritime semi-arid climate **Operational period:** Year-round operation **Nearest town/settlement:** located ca. 5 km north of the village of Utqiaġvik (formerly Barrow, AK; opulation 5256) at the northern tip of Alaska on the Chukchi/Beaufort Seas. Utqiaġvik is serviced by commercial airlines with daily flights, year-round. Boat access during the summer **Contact point:** Lindsay Cameron <Lindsay.Cameron@UICCS.com> **Other:** Barrow Environmental Observatory comprises 30 km2 of tundra, lakes, and wetlands reserved for scientific research and long-term environmental monitoring, with interest in the deployment of passive contaminant samplers.
Villum Research Station			√	√	**Country:** Greenland **Climate zone:** High Arctic, near ice cap and marine system with multiyear and seasonal sea ice transport **Operational period:** Station open year-round (military), restricted access **Nearest town/settlement:** no nearby community **Contact point:** Henrik Skov <hsk@envs.au.dk> **Other:**

INTERACT Station	Existing PAS deployment	Existing PWS deployment	Interest in PAS deployment	Interest in PWS deployment	Site information
WARC	√			√	**Country:** Canada **Climate zone:** Subarctic tundra, south of the treeline, continuous permafrost **Operational period:** Year-round operation **Nearest town/settlement:** Located in the town of Inuvik, NWT (population 3300); accessible by commercial flights; field transport can include car/truck, snowmobile, boat, charter plane, or helicopter. **Contact point:** Erika Hille <Erika.Hille@auroracollege.nt.ca> **Other:** PAS are installed at two locations near the research centre. No PWS currently deployed; Interest in deploying PWS in Miner River. There is also the option to do active sampling, however, sampling frequency would be heavily limited by the remoteness of the site. Miner River and Peel River would be possible sites for deploying (Hg) air or water PS to study changes in mercury flux in watersheds impacted by climate change; Peel River is of particular interest to local communities.
Zackenberg			√	√	**Country:** Greenland **Climate zone:** High Arctic in an area with continuous permafrost **Operational period:** Station open from April to September/ October. **Nearest town/settlement:** No nearby community; located in Young Sund/Tyrolerfjord in the southern part of NE Greenland national park; nearest settlement is Daneborg (military outpost) 25 km from station; nearest town is Ittoqqortoormiit (450 inhabitants, 450 km distant). Access via combination of commercial and charter flights. **Contact point:** Marie Frost Arndal mfa@ecos.au.dk, Mikhail Mastepanov <mikhail.mastepanov@ecos.au.dk> **Other:**

2.3.1.GAPS PAS Network:

Contacts: Tom Harner (ECCC) Tom.Harner@ec.gc.ca and Amandeep Saini (ECCC) Amandeep.Saini@ec.gc.ca

Follow-up: Several INTERACT station coordinators indicated a willingness to partner with ECCC on passive air sampling, given the simplicity and minimal effort involved. There was interest in both GAPS network and Mercury passive samplers. Samplers would be deployed at no cost to ECCC. Based on initial discussions and outreach by INTERACT site coordinators, the GAPS Network is positively considering options for deploying PUF disk samplers at INTERACT sites (n= 2 to 4) starting as early as spring/summer 2023 to address spatial gaps in coverage for the Arctic region. This pilot phase could include mercury passive samplers, which will be discussed further with Sandy Steffen.

Sampling at INTERACT stations using PUF disk samplers would be carried out during two periods each year. A summer period spanning May/June to September and a winter period (September to May/June). One sampler housing, and three PUF disks (one for field blank) would be shipped to each site. Sampling for the first period for sites 1 and 2 would include a station site as well as a remote (off station) site to assess potential local sources affecting POPs concentrations around the station.

Initial sites starting in May/June 2023

- Site 1: Kangiqsualujjuak Sukuijarvik (2 samplers)
- Site 2: Whapmagoostui-Kuujjuarapik (W-K) (2 samplers)
- Site 3: Bylot Isl.
- Site 4: Kobbefjord (KB) (Greenland)

Potential future sites

- Site 5: Imiujaq
- Site 6: Clearwater Lake
- Site 7: Salluit
- Site 8: Cairngorms Nat'l Park (Scotland)

To reduce shipping costs and simplify storage, we will also discuss exploring the option to store PUF disks in aluminium foil envelopes within ziplock bags, and using a metal canister to hold all PUF disk for a given year. Blank tests will need to be performed in advance of implementing this new approach, especially for trace metals analysis (e.g., Al).

Documentation: GAPS SOP for the deployment of the PUF disk sampler in air.

2.3.2.AQUA GAPS/MONET PWS Network:

Contact: Branislav Vrana <branislav.vrana@recetox.muni.cz>

Follow-up: No contact yet with individual stations. A publications from the pilot campaign of AQUA GAPS is currently being finalized. Based on the information compiled in this deliverable, contacts with INTERACT stations will be developed in the near future. For marine deployments seawater-resistant stainless steel holders need to be arranged, ideally, making use of existing holders within our network.

Documentation: Example protocol for deployment of PWS in AQUA-GAPS. This type of open cages is applicable in both marine and freshwater deployments. Freshwater deployments are generally much easier since deployment is possible using simple stainless steel BBQ frames that are easy to transport or obtain locally. Passive samplers are available from RECETOX.

Further details are available at this dedicated website: http://www.aqua-gaps.passivesampling.net/

An illustrative video on deployment of aquatic passive samplers in freshwater is here:

https://www.youtube.com/watch?v=or0CdVRewRQ

2.3.3.National Networks - Canada:

Contact: Hung,Hayley (ECCC) <Hayley.Hung@ec.gc.ca>

Follow-up: In addition to PAS and PWS-based approaches, deliverable D8.2 also presented options for pilot implementation of contaminant monitoring at INTERACT sites based on sampling of environmental media, including snow samples. A snow and sea ice sampling campaign is being planned at Alert in April/May 2023 (currently pending approval). While awaiting this, it is planned to reach out to some INTERACT station leads to see if they can do some snow sampling around the same time of the campaign. The hope would be to get samples from about 10 INTERACT sites to get a good spatial coverage. Together with samples from a campaign monitoring at two AMAP/Northern Contaminants Program monitoring sites (Alert (Nunavut) and Little Fox Lake (Yukon)), there would be interest in analysing snow samples from Hudson Bay, Greenland, Norway and Finland.

Meetings are planned between representatives of ECCC and Erika Hille (WARC site) in Inuvik in February 2023 regarding interest in deploying passive water sampling for mercury.

3. Next Steps

- The information contained in this deliverable will be communicated to INTERACT station managers.
- WP8 will continue to follow-up with operators of passive sampler and snow sampling networks to track progress in pilot implementation initiatives.
- The INTERACT Station-managers Forum (WP2) will endeavour to collect relevant guidance materials and training videos, etc. from the passive sampler networks (or links to these) as a resource that can be further investigated by INTERACT station operators interested in passive sampler deployment. This will also provide a basis for possible feedback to the networks on whether the current guidance is suitable and understandable. In this connection it is noted that some stations do not have access to internet or internet services that can support download of large files and/or streaming of videos so networks may need to consider formats for delivering guidance documents and videos that are appropriate to circumstances at some Arctic sites. Reference is made to documentation noted in sections 2.3.1 and 2.3.2 above.
- INTERACT WP8 and WP2 leads will conduct further workshop follow-up, including (for WP8) looking into possibilities to reallocate resources to support practical work that could extend pilot implementation of contaminant monitoring using PAS and PWS at additional INTERACT sites in the last year(s) of the project' and if further possibilities exist for funding virtual access, for linking this work to those funding opportunities.

4. Glossary

CEACs: Chemicals of Emerging Arctic Concern

PAS: passive air sampler

POPs: Persistent Organic Pollutants

PWS : passive water sampler

Appendix 1: WP8 Workshop to Promote the Use of Passive Air and Water Samplers for Pilot Implementation of Contaminants Monitoring at Interact Stations

To develop the proposals and options for pilot implementation of contaminants monitoring at INTERACT stations, a (hybrid) workshop was arranged (7 December 2022) as a side-event to the ArcticNet Conference in Toronto, Canada. Objective and agenda for the workshop are listed in Workshop Annex A).The main aim of the meeting was to facilitate connections between coordinators of passive sampler networks and INTERACT stations.

The workshop attracted ca. 30 participants representing 5 passive sampler communities and 19+ INTERACT Stations (see Workshop Annex B).

Passive Sampler Network Introductions

- GAPS: Tom Harner (in-person) and Amandeep Saini (virtual) provided an introduction to the GAPs passive air sampler (PAS) network (see Workshop Annex C). GAPS is a global network that provides data on Persistent Organic Pollutants (POPs) and Chemicals of Emerging Concern (CEC) for, e.g., use in the Stockholm Convention's Effectiveness Evaluation process. At some sites in the network, PAS have also been applied to study possible local pollution (see Alert example in Workshop Annex C). PAS may also be suitable for applications to monitor other airborne particles (including microplastics and black carbon), but this needs further research and development.
- AQUA GAPS/Monet: Branislav Vrana (virtual) and Rainer Lohmann (in-person) provided an introduction to the AQUA GAPS/Monet passive water sampler (PWS) network (see Workshop Annex D). AQUA GAPS/Monet is a more recent network initiative but with similar potential to serve as a global network to monitor POPs and CECs in aquatic systems. Work is currently focussed on monitoring at background sites, and filling geographical gaps in the network including Arctic locations is a current objective.
- NORMAN: Katrin Vorkamp (in-person) introduced the non-target screening (NTS) activities under the NORMAN network which include both PAS (for indoor and outdoor air) and PWS components. NTS is an approach that in particular is looking at environmental occurrence of new chemicals including substances that would not normally be covered under existing POPs monitoring programmes as well as 'unknown' substances recorded during sample analyses.
- Derek Muir provided some insights into use of PWS in Canadian research and monitoring activities, including lake studies in Arctic locations.
- Katrin Vorkamp informed about efforts to establish national PWS monitoring for CEC at sites in Greenland. Connections established through INTERACT resulted in trial deployment of PWS in the fjord (Kobberfjord) at the GINR station; however these deployments proved unsuccessful. Katrine Raundrup informed about the practical experiences with this deployment and the lessons that could be learned (see discussions below).

Discussion and follow-up questions from INTERACT sites

- Challenging environmental conditions can limit suitability of Arctic locations for deployment of PAS and WS. In particular low concentrations of pollutants in Arctic air are a potential limitation. Tom Harner explained that this can be overcome by deploying PAS for e.g. 6-month (or longer) periods rather than the normal 3-months to accumulate contaminants on the PUF discs in the PAS to concentrations that can be reliably measured. Similarly PWS can be deployed for extended periods (of up to a year) which can also overcome possible access issues associated with ice on water and/or seasonal availability of personnel to deploy/retrieve the samplers.
- Requirements for deploying PAS and PWS are minimal; PAS samplers can be attached to existing structures or e.g. trees; PWS are likely to require access to boats for deployment, but can also be deployed by drilling through ice. After deployment no maintenance is normally required until the sample is retrieved. PAS and PWS can be reused once deployed, replacing only the PUF plugs or silicon discs that collect the chemicals of interest and are returned to laboratories for analysis. PAS and PAW do not require a power supply making them suitable for deployment both on-site (at stations) and off-site (away from or intentionally close to potential local sources of contamination).
- The most costly component of work involving passive samplers are the costs of sample analysis; the GAPS and AQUA GAPS programmes have access to resources to cover these costs – but these would be applied to samples that best meet the requirements of these programmes. In other cases it would be necessary to identify funding for laboratory analysis of samples; more minor costs are associated with shipping of samplers and sampler materials but these are minimal. Passive samplers normally use pre-prepared/packaged sampling materials shipped from laboratories that will conduct subsequent analysis. In considering use of passive samplers to study local pollution sources, costs would need to take account of the value of the data at the local level compared to e.g. their use at the global level.
- Programmes typically provide instructions, SOPs and training (e.g. video training) on how to construct and deploy the samplers. Part of the experience noted in connection with deployment of PWS at the GINR site concerned quality of instructions for constructing the sampler. This resulted in recommendations for improvements to written instructions and protocols, and for practical testing of these by potential (non-expert and non-native English speaking) users in advance. Guidance/training may also be important in relation to retrieving/changing samples to avoid contamination. Making available existing instructions and guidance concerning PAS/PWS deployment at Arctic sites, and improving/testing these protocols should be part of any follow-up INTERACT activity.
- PWS are normally deployed in marine settings or lakes; they have been deployed in small relatively shallow lakes (of ca. 1 km^2) as well as large lakes. PWS could be deployed in rivers/streams but still vs running water will affect the volume of water to which the sample materials are exposed.
- One issue noted in connection with deployment of PAS and PWS at Arctic sites to date concerned the problem of loss of or damage to samplers, both accidental and intentional. Samplers deployed off-site (outside station boundaries) may be more likely to be subject to damage as a result of curiosity or vandalism. PAS have been used for target practise, PWS may attract attention of fishermen – in this latter context it was noted that deployments in lakes that are not used for fishing may be preferable to some marine situations. Deployment under ice may also give advantages in this respect. Some INTERACT sites are remote from any local communities; at other sites engagement with local communities, e.g. in connection with community-based monitoring studies may lessen the chance of damage or loss of samplers.

- Results of passive sample analyses would be provided to the collaborating partners (i.e. stations) for their own use as well as being used, e.g., by international monitoring programmes.
- INTERACT remote access funding may be a mechanism to cover site-operation costs if extended (deadlines for proposals for RA under the current scheme have passed).
- Other types of sampling could be considered at INTERACT stations, including e.g. collection of snow samples. A snow sampling campaign at Alert (Ellesmere Island) is planned for 2023 (contact: Hayley Hung (ECCC) <Hayley.Hung@ec.gc.ca>)

Workshop Follow-up

- The main objective of the workshop – to facilitate communication between PS Networks and interested INTERACT stations – will be conducted through tracked conversations. Some initial responses posted in the meeting 'chat' are noted in Workshop Annex B. Parties involved in any subsequent follow-up are requested to cc. simon.wilson@amap.no on relevant e-mail exchanges, etc.
- The SMF will endeavour to collect relevant guidance materials and training videos, etc. from the passive sampler networks (or links to these) as a resource that can be further investigated by INTERACT station operators interested in passive sampler deployment. This will also provide a basis for possible feedback to the networks on whether the current guidance is suitable and understandable. In this connection it is noted that some stations do not have access to internet or internet services that can support download of large files and/or streaming of videos so networks may need to consider formats for delivering guidance documents and videos that are appropriate to circumstances at some Arctic sites.
- INTERACT WP8 and WP2 leads will conduct further workshop follow-up, including (for WP8) looking into possibilities to reallocate resources to support practical work that could extend pilot implementation of contaminant monitoring using PAS and PWS at additional INTERACT sites in the last year(s) of the project.

Workshop Annex A: Workshop Programme

1. Brief introduction of each passive sampler network (max 5 mins per network) to explain their respective areas of work, covering:
   - Practical aspects involved in shipping, deploying and retrieving samplers (training and instructions, potential contamination issues, etc.)
   - Potential interest in deploying samplers at Arctic sites and associated requirements, types of site they are looking for, timeframes for possible work, etc.

2. . Some relevant issues to raise could include, e.g.
   - Suitability of sites in terms of location relative to types of deployments desired,
   - Deploying samplers at station vs deployment in surrounding areas
   - Available station resources (man-power, boats, etc.)
   - Timing aspects (site manned by relevant personnel at appropriate times for deployment/retrieval?)
   - Site climate/weather/ice conditions that could constrain work (ice on water)
   - Community engagement (how to avoid interference with samples, arranging permissions for work, etc.)
   - Funding issues

3. Identification of follow-up
   - INTERACT WP2/WP8 follow-up
   - Bilateral follow-up between networks and stations

Workshop Annex B: Workshop Participants

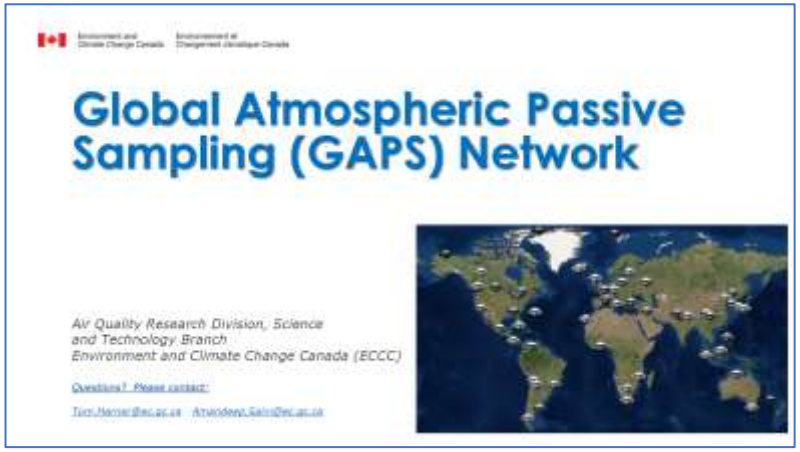
Network/Station	Name	Participation	Meeting chat extracted notes, etc.
Passive Sampler Network			
AQUA GAPS/MONET	Rainer Lohmann	in-person	
NORMAN (air) / PARC / National	Katrin Vorkamp	in-person	
National		unavailable	
AQUA GAPS/MONET	Branislav Vrana	remote	The contact to AQUA-GAPS/MONET aquatic passive sampling network: <aqua-gaps@recetox.muni.cz>
National	Derek Muir (ECCC)	in-person	
GAPS	Tom Harner (ECCC)	in-person	
GAPS	Amandeep Saini (ECCC)	remote	To contact the GAPS PAS network, contact Tom Harner <tom.harner@ec.gc.ca> or Aman Saini <amandeep.saini@ec.gc.ca>
INTERACT station			
Abisko	Emily Pickering Pedersen	remote	Please feel free to get in touch if Abisko, northern Sweden, is of interest for installing PAS and PWS.
Arctic DTU Research Station	Steffen Ringsø	remote	
Arctic Station	Charlotte Sigsgaard	remote	Welcome to contact Charlotte Sigsgaard (cs@ign.ku.dk) regarding deploying passive samplers near Arctic Station, Disko, Western Greenland
CEN - Whapmagoostui-Kuujjuarapik	Mickael Lemay	in-person	To further discuss the way forward to install PAS in Whapmagoostui-

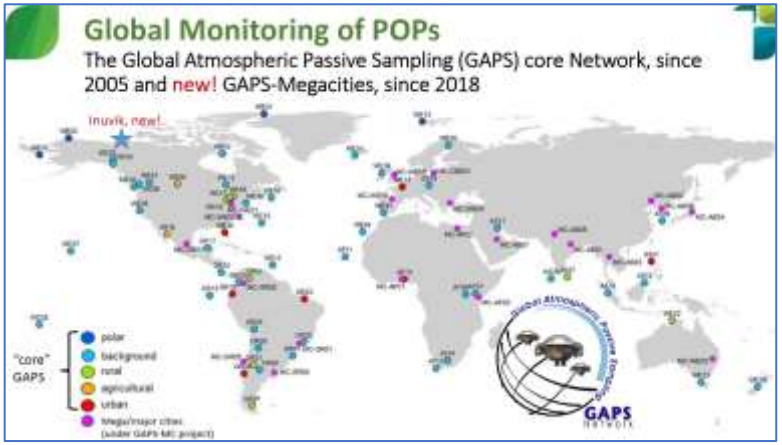
CEN – Kangiqsuallujjuak (and CEN – Umiujaq, CEN – Salluit and CEN – Bylot Island)			Kuujjuarapik and Kangiqsuallujjuak (Nunavik), I reiterate our interest at CEN to deploy your samplers at these 2 stations. We could maybe install 2 per site, one in the station vicinity (probably recording the influence of the diesel electric central) and one outside the community in the natural environment (far from direct sources of contamination). We could start with this and maybe add more remote sites like Bylot Island next year, with an irregular sampling frequency of the PUF – i.e. from August/September to May/June (winter) and from May/June to August/September (summer). Other possible sites would be Umiujaq, Salluit and Clearwater Lake
GINR	Katrine Raundrup	remote	Welcome to contact me at <kara@natur.gl> at the Greenland Institute of Natural Resources regarding setting up the GAPS and the freshwater passive samplers
Oulanka	Riku Paavola	remote	Oulanka research station in NE Finland might be interested in hosting a passive sampler. Station is nearly on the Arctic Circle, close to the border with Russia, in a national park (taiga, north boreal)
Petunia Bay (Svalbard)	Juliana Kasprzyk	remote	Polish station in Spitsbergen (Petunia Bay near Pyramiden). It would be easy to send the samplers between Poland and Czech.

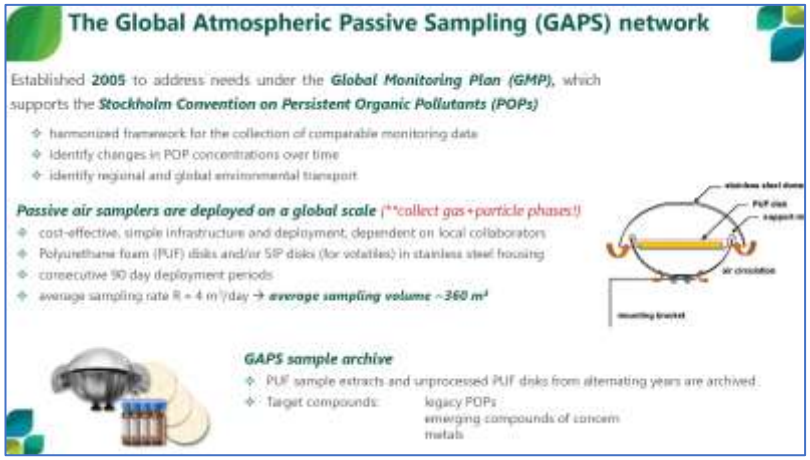
			Will contact AQUA-GAPS/MONET
Qaanaaq	Steffen M. Olsen	remote	
RIF, Iceland	Pedro Rodrigues	remote	If interest in deploying passive samplers in the middle of the Atlantic, I can put you in contact with researchers from the University of the Azores
Sodankylä	Anna Kontu	remote	Sodankylä in Northern Finland is interested in PAS
Sudurnes Science and Learning Center	Sölvi Rúnar Vignisson	remote	Welcome to contact us at SW Iceland if you want to deploy passive samplers and/or samples from ocean, air or lakes in Iceland. solvi@thekkingarsetur.is
Tarfala Research Station TRS	Annika Granebeck	remote	
Toolik	Syndonia Bret-Harte	remote	Toolik will continue to offer remote access after INTERACT ends. If interest in deploying samplers, contact <msbretharte@alaska.edu>
UK Centre for Ecology & Hydrology (UKCEH) Cairngorms	Jan Dick Christopher Andrews	remote	We can offer rural site in Cairngorms Scotland if that would be helpful UKCEH station has long-term environmental monitoring program so are always interested in being part of networks. Contacts: <jand@ceh.ac.uk> and <chan@ceh.ac.uk>
Utqiaġvik, AK	Lindsay Cameron	remote	
Villum Research Station	Henrik Skov	remote	
WARC	Erika Hille	remote	Interest in possible (mercury) PS deployment. In particular, interest in how

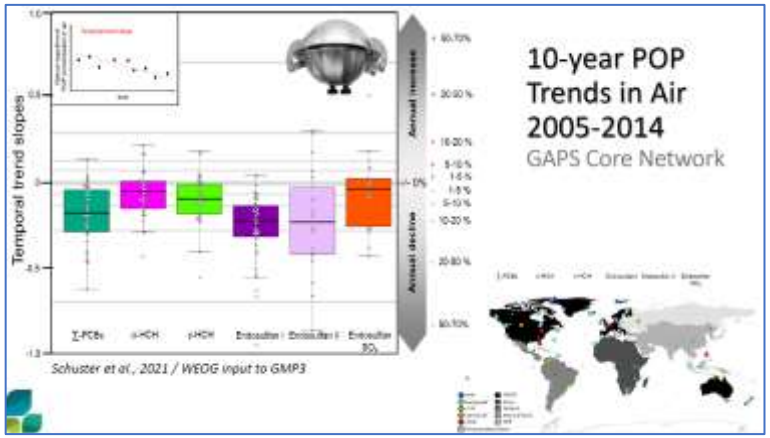
			the flux of particulate mercury changes along the main channel of a river impacted by multiple retrogressive thaw slump and mega slump features (Miner River). Another possible site could be the Peel River. The Peel watershed is heavily impacted by thermokarst features. Changes in sediment and contaminant fluxes along the Peel River is of particular interest to local communities and in turn, the scientific community.
Zackenberg	Marie Frost Arndal Mikhail Mastepanov	remote	Please contact Secretariat Zackenberg <zackenberg@au.dk>
INTERACT III WP2 Station Managers Forum	Susse Wegeberg	remote	
INTERACT III WP8 lead	Simon Wilson	in-person	

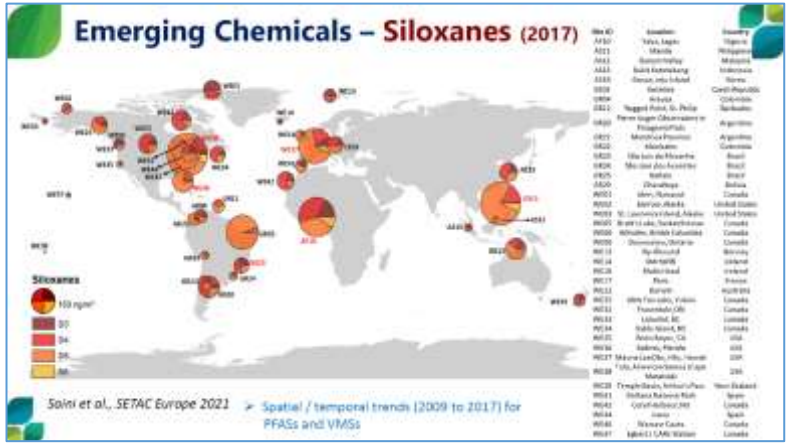
Workshop Annex C: Global Atmospheric Passive Sampler Network – GAPS (slide subset)

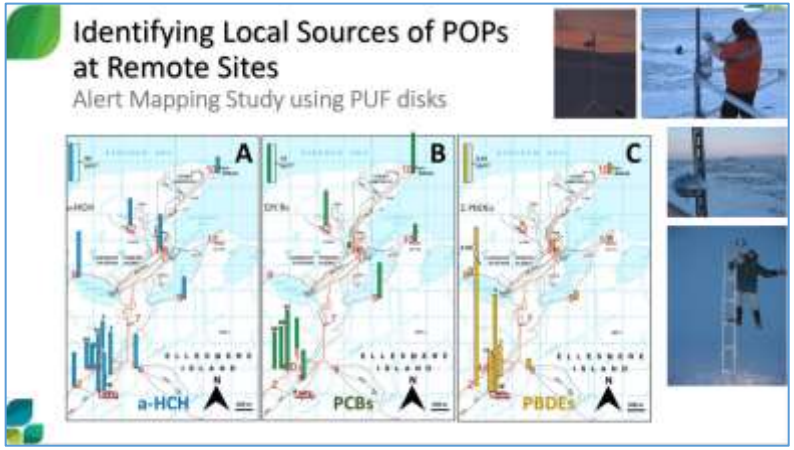


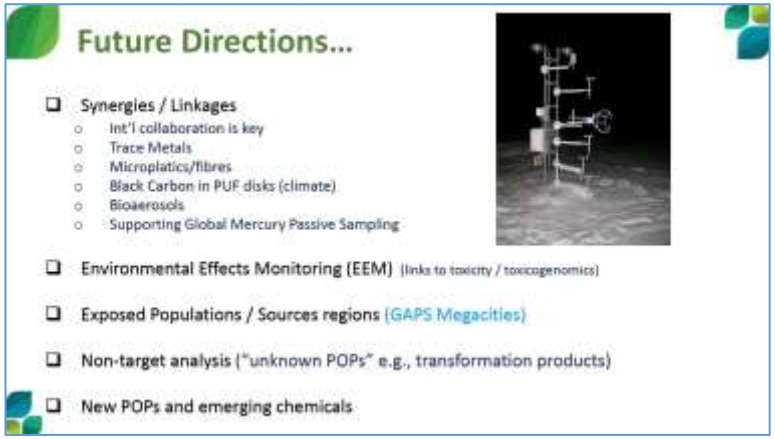







Emerging Chemicals – Siloxanes (2017)
Siloxanes
Saini et al., SETAC Europe 2021
Spatial / temporal trends (2009 to 2017) for PFASs and VMSs


Identifying Local Sources of POPs at Remote Sites
Alert Mapping Study using PUF disks
A
B
C
a-HCH
PCBs
PBDEs


Future Directions...
Synergies / Linkages
Int'l collaboration is key
Trace Metals
Microplatics/fibres
Black Carbon in PUF disks (climate)
Bioaerosols
Supporting Global Mercury Passive Sampling
Environmental Effects Monitoring (EEM) (links to toxicity / toxicogenomics)
Exposed Populations / Sources regions (GAPS Megacities)
Non-target analysis ("unknown POPs" e.g., transformation products)
New POPs and emerging chemicals

Annex D: AQUA GAPS/Monet Passive Water Sampler Network (slide subset)

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Stockholm Convention
Regional Centre

New global network tracing POPs in water: Aqua-GAPS/MONET first results

Branislav Vrana
branislav.vrana@recetox.muni.cz

INTERACT Stations - Passive Sampler Networks
(Hybrid)Workshop 07 December 2022

New global network tracing POPs in water: Aqua-GAPS/MONET

Foppe Smedes
Branislav Vrana RECETOX, Masaryk University
Jaromir Sobotka Brno, Czech republic

Rainer Lohmann University of Rhode Island, USA

Derek Muir Environment and Climate Change Canada

Eddy Zeng Jinan University, Guangzhou, China
Lian-Jun Bao

and **the sampling teams**

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The objective

Provide information
On levels and trends of POPs in the aqueous environment
at sites with background contamination
which are spatially and temporally comparable
on a global scale

this is achieved by passive sampling

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Why monitoring using passive sampling

Passive sampling is like actively adding/inserting
an artificial compartment -with defined composition and properties- into the environment

Confirms to the major rule in environmental monitoring:
"the matrix of collected samples must have defined (or constant) properties over time and space"

POPs concentration in the silicone at equilibrium with water are globally comparable

Conversion to other defined matrices:
- freely dissolved concentration
- lipid basis

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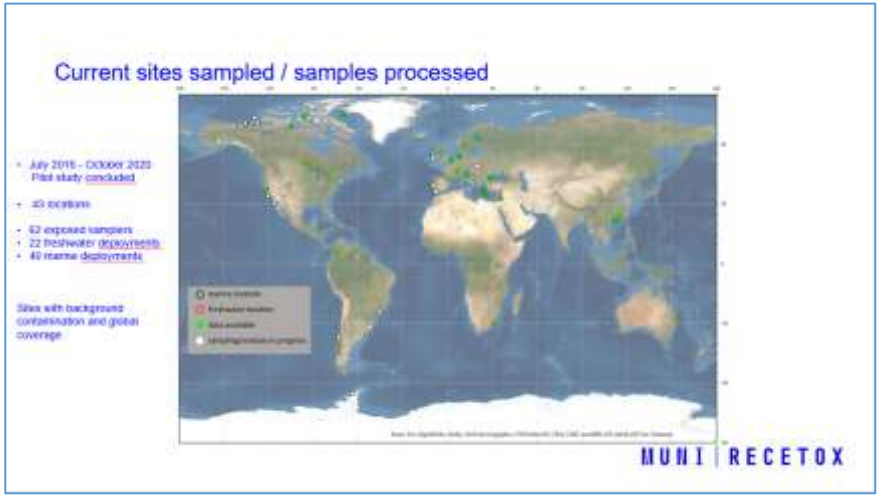
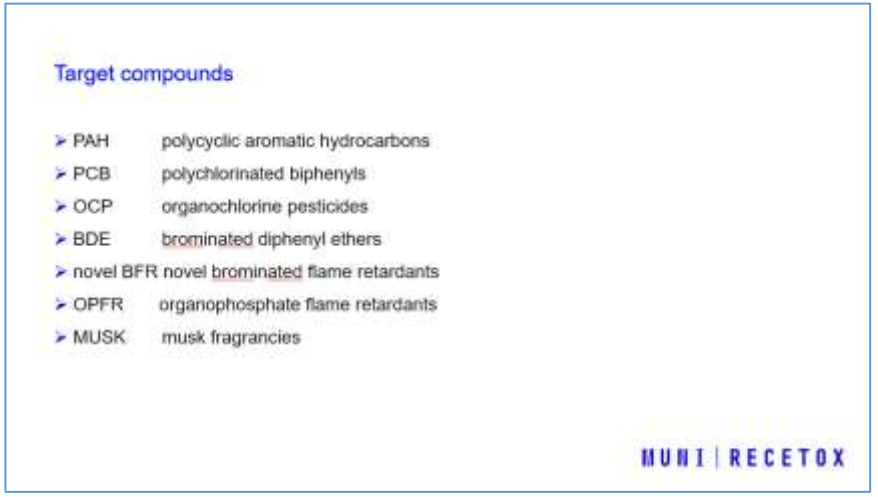




How does passive sampling work in practice

RECETOX, Masaryk University

sends samplers to voluntary participants

who deploy the samplers in the field

according to provided instructions

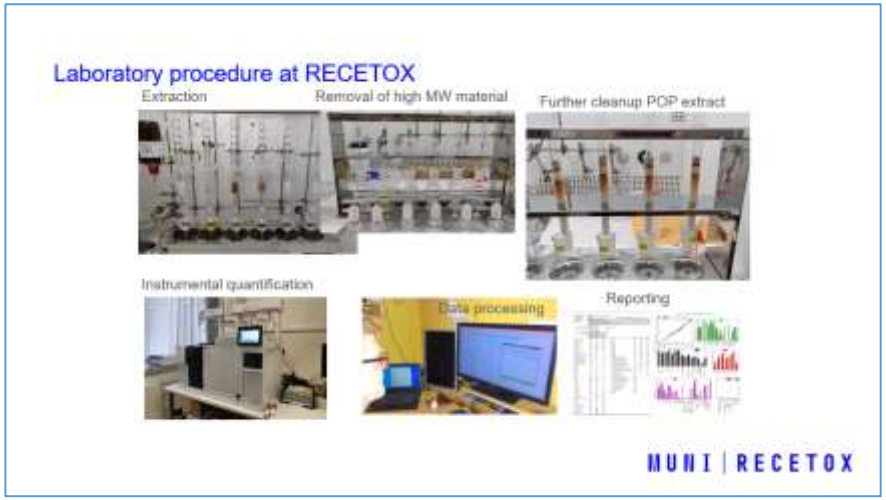
After exposure of 6 weeks to one year

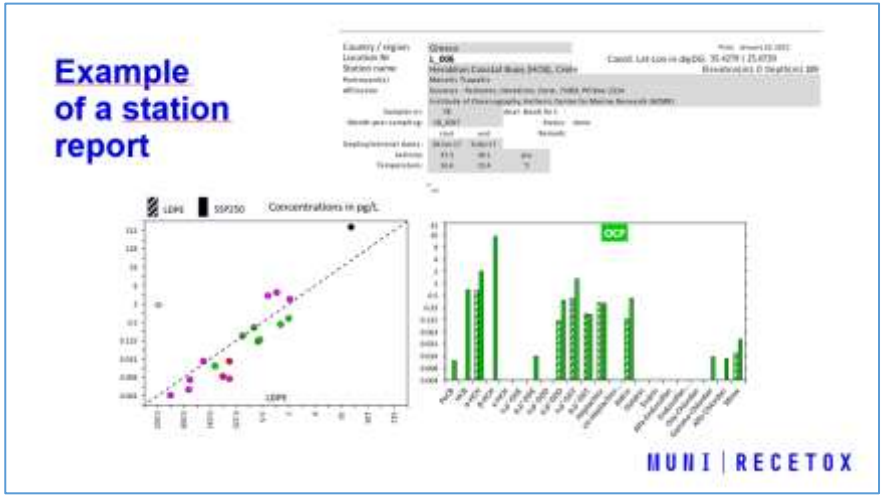
participants retrieve the samplers

clean them with local water

and send them back to

RECETOX, MASARYK University, Czech Republic




Example of a station report
Concentrations in pg/L
OCP
MUNI | RECETOX