Microplastics in Greenland air – deposition in snow

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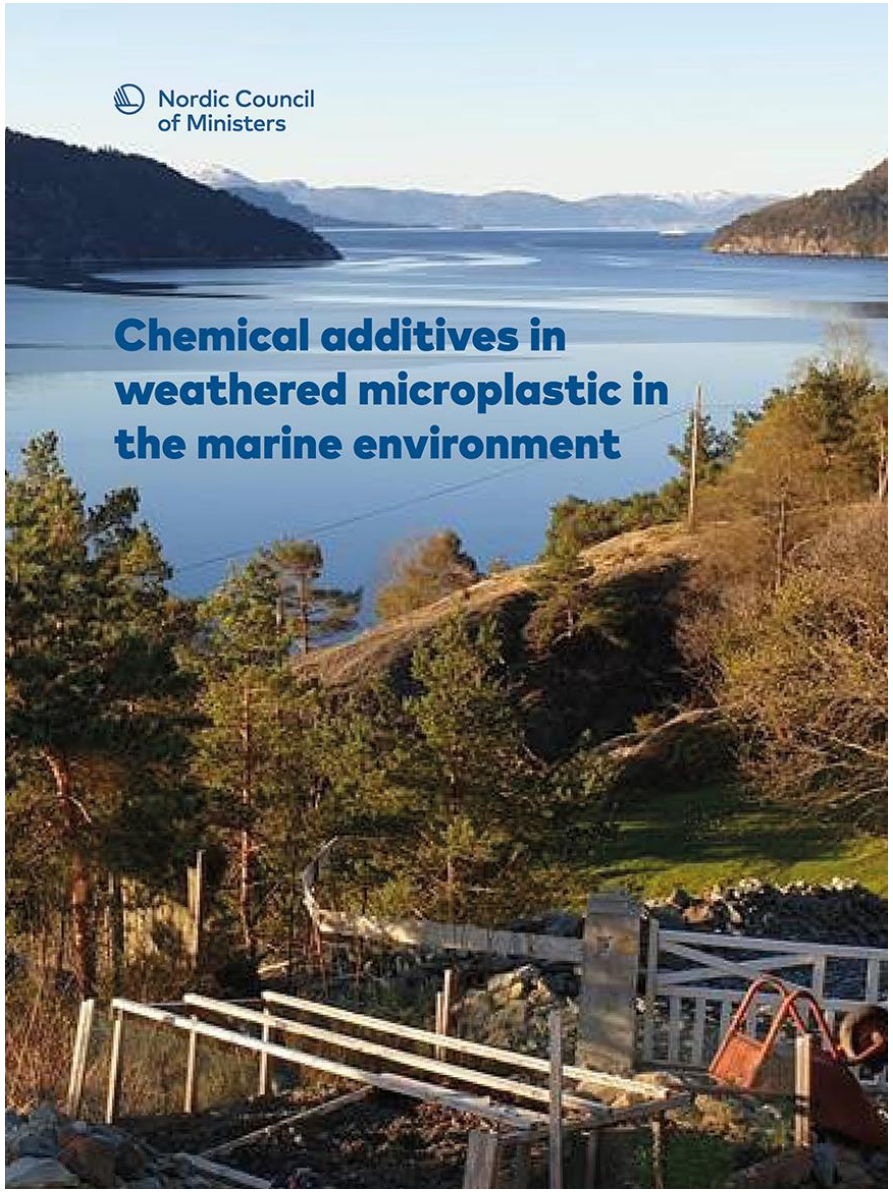

Marine Pollution Bulletin 177 (2022) 113467

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Review

Residual additives in marine microplastics and their risk assessment – A critical review

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Risk assessment of added chemicals in plastics in the Danish marine environment

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Project team at Aarhus University

Jakob Strand, Rossana Bossi, Henrik Skov, Annegrete Ljungqvist, Christel Christoffersen, Vitor Hugo da Silva






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Ministry of Environment of Denmark

Ministry of Environment of Denmark
Environmental Protection Agency

2019

It's snowing micro-plastics in the Arctic and the Alps, research suggests

Updated 15 Aug 2019, 3:29am

PHOTO: Microplastics were discovered in snow samples taken from Switzerland (pictured), among other areas. (AP)

Microplastics 'significantly contaminating the air', scientists warn

Discovery of pollution in snowfall from the Arctic to the Alps leads to call for urgent research on potential human health impacts

Scientists collect snow samples above the Arctic circle. Photograph: Melanie Bergmann/Alfred-Wegener-Institut/Science Advances

https://www.abc.net.au/news/2019-08-15/microplastic-snow-ice-cores-arctic-pollution-travel-research/11416188 ;
https://www.theguardian.com/environment/2019/aug/14/microplastics-found-at-profuse-levels-in-snow-from-arctic-to-alps-contamination

2023

https://e360.yale.edu/features/plastic-waste-atmosphere-climate-weather

State of research

Science of the Total Environment 874 (2023) 162193

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There's something in the air: A review of sources, prevalence and behaviour of microplastics in the atmosphere

Stacey O'Brien [a,*], Cassandra Rauert [a], Francisca Ribeiro [a,d], Elvis D. Okoffo [a], Stephen D. Burrows [a,d], Jake W. O'Brien [a], Xianyu Wang [a], Stephanie L. Wright [b,c], Kevin V. Thomas [a]

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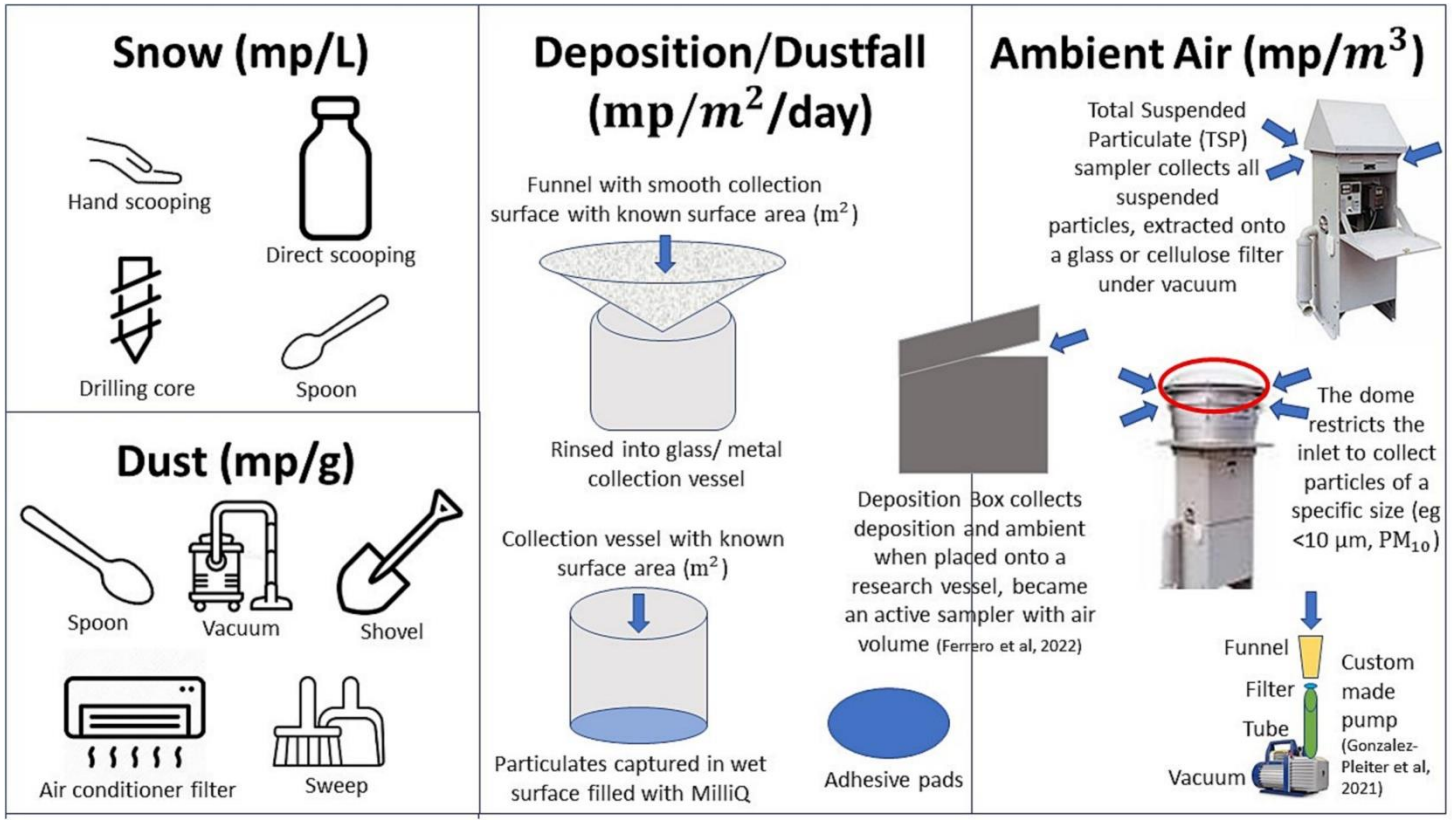

Monitoring recommendations

Priority 1
Immediate trend monitoring

- Water
- Aquatic sediments
- Beaches/ shorelines
- Seabirds

Priority 2
Initial baseline mapping and future trend monitoring

- Atmospheric deposition
- Invertebrates
- Fish

Compartments to be further developed for source/surveillance and effects monitoring

- Seabeds
- Ice/Snow
- Terrestrial soils
- Mammals

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NORDIC SCREENING | KATRIN VORKAMP

Villum Research Station

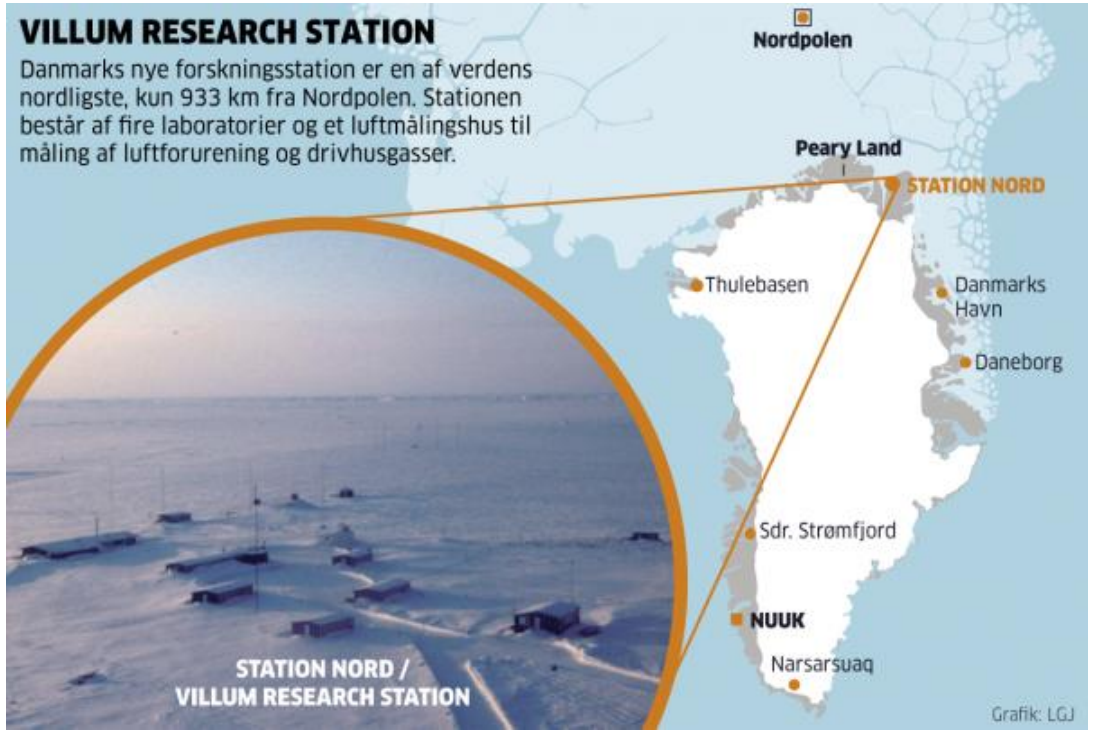

Table 3.1. List of parameters of compounds and parameters.

Activities	Data availability	Instruments
Filter pack measurements of SO_2, SO_4^{2-}, NO_3^- and NH_4^+	1990 - June 2002 and July 2006 - present	IC and segmented flow analyzer
Filter pack measurements of elements from Al and higher (except Cl, and Hg)	1990 - June 2002 and July 2006- present	ICP-MS
O_3	1997-2002 and 2006 – present	O_3 monitor using UV absorption
Gaseous Elemental Mercury (GEM)	August 1999 – 2002 and 2006- present	GEM monitor using Cold vapour fluorescence spectroscopy
Black Carbon	2008 - present	(PSAP, MAAP)
CO	July 2016 - present	CO monitor using IR absorption spectroscopy. From 2012 a CO monitor using gas chromatography and a Hg reduction detector
High volume sampling equipped with particle filtre and PUF, XAD, PUF sandwich plug to measure chlorinated pesticides.	July 2006 - present	GC-HRMS, LC-MS-MS
Brominated flame retardants measured with high volume sampler (same as chlorinated pesticides)	July 2006 - present	
Persistent fluorinated compounds measured with a specially designed high volume sampler	January 2007 - present	
CH_4 and CO_2 gradients with a Picaro; Leico	January 2012 - present	Cavity ring down method
Meteorological parameters*	At least from 1961	Synoptic data
Climate: Wind speed, wind direction, temperature, relative humidity, solar flux (in and out), precipitation, snow depth,	July 2014 - present	Set up by ASIAQ (Greenland)

www.villumresearchstation.dk ; Skov et al. (2017) DCE Technical Report101, 77 pp, http://dce2.au.dk/pub/TR101.pdf

Microplastic lab

- Instrumentation (µFTIR)
- Clean lab
- Experience with microplastic analyses

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Improved separation and quantification method for microplastic analysis in sediment: A fine-grained matrix from Arctic Greenland

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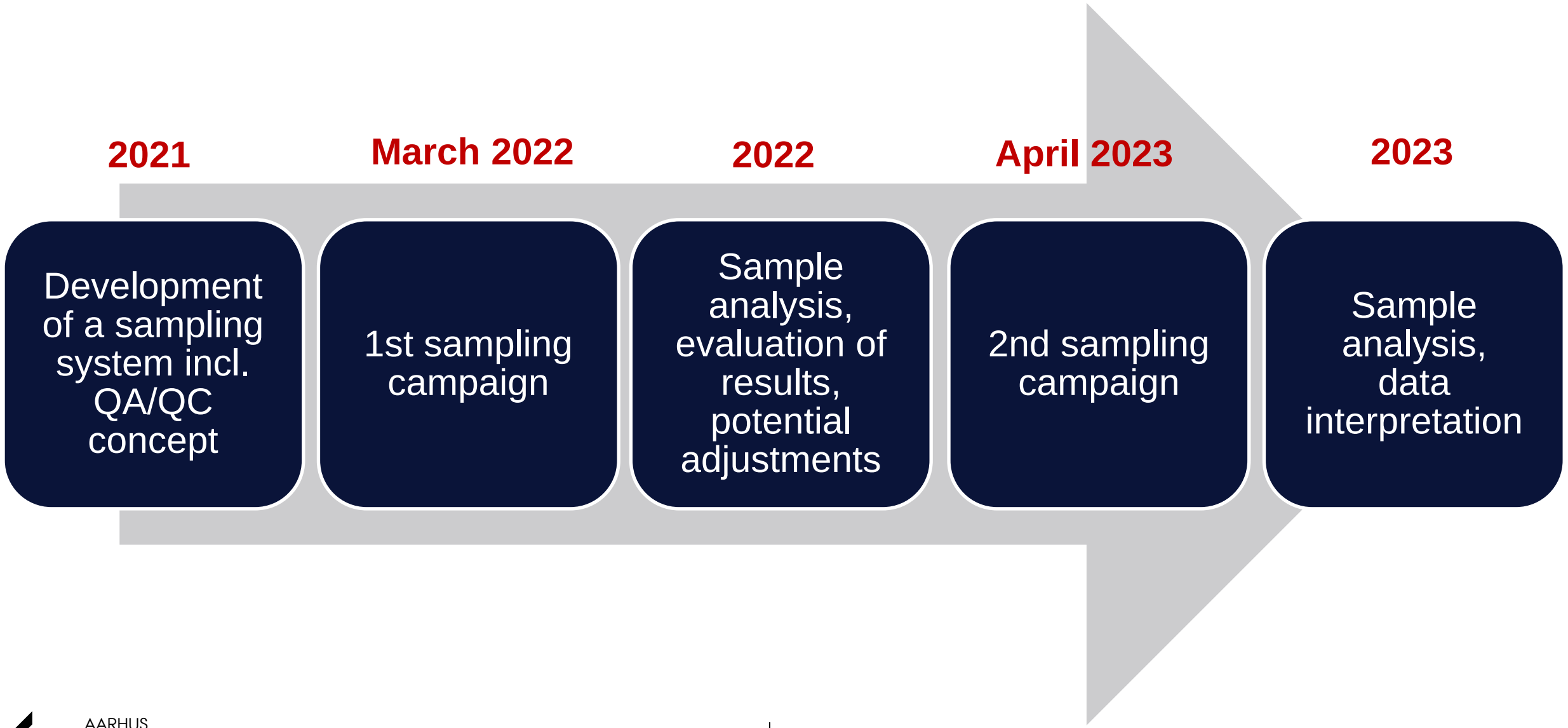
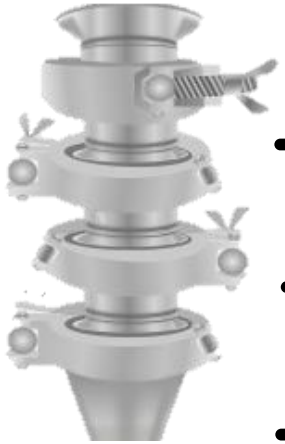
Project plan



First sampling campaign

90 L

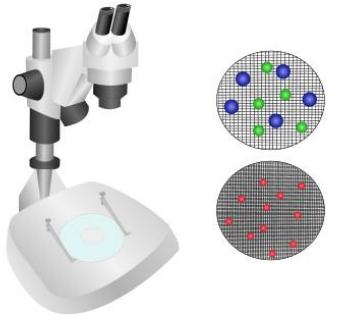
15 L



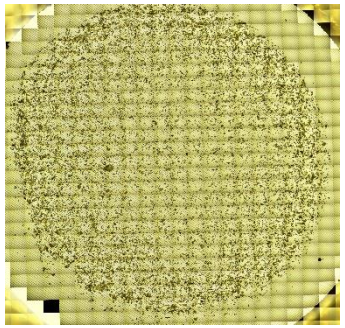
100 µm

20 µm

1 µm



Visual Analysis



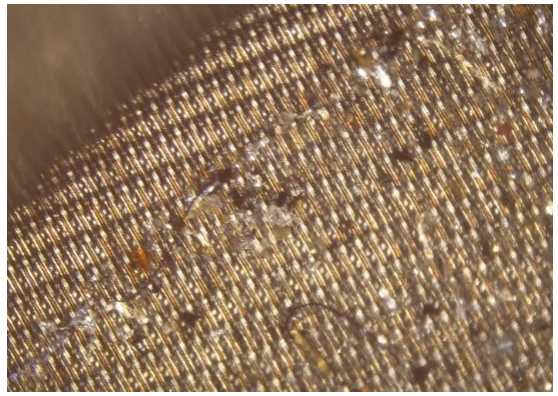
µFTIR

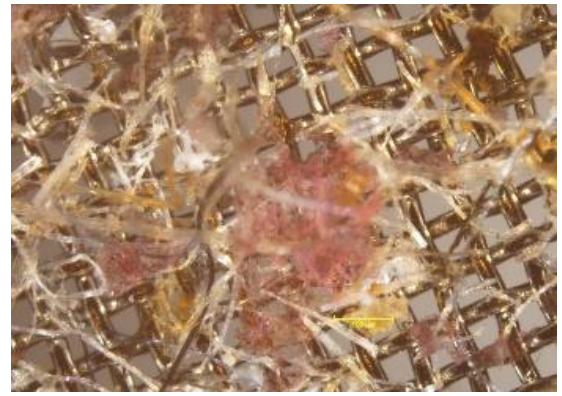
later

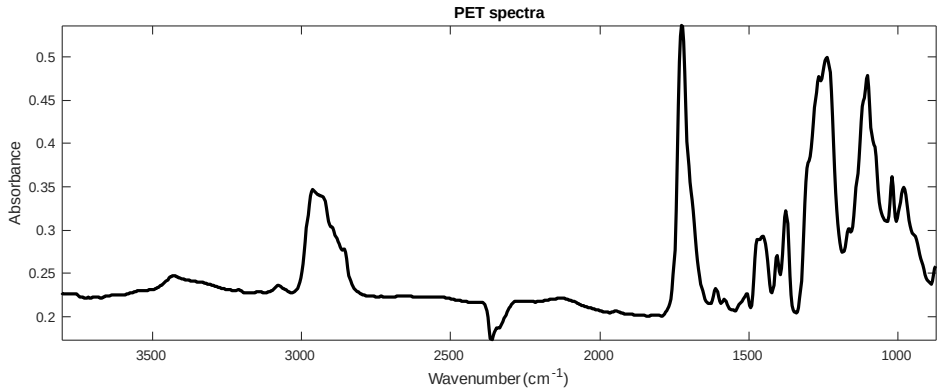
Disappointing results

- Melting 100 L of snow took several days
- The cleaning blank contained high levels of both small and larger particles, mainly PES
- Duplicate samples did not match.

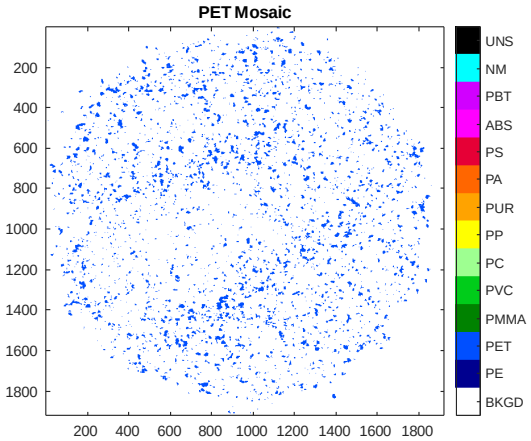
> 100 µm

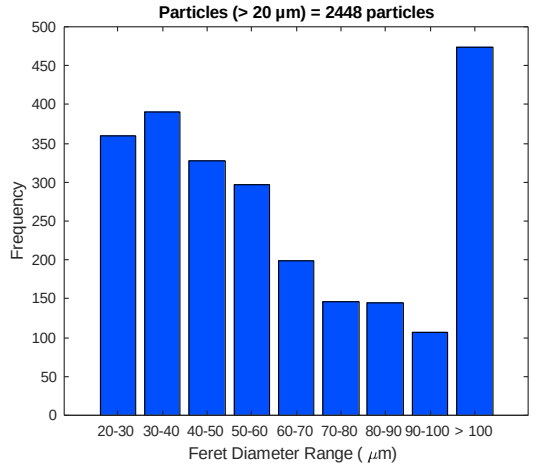






> 20 µm
~ 5 L





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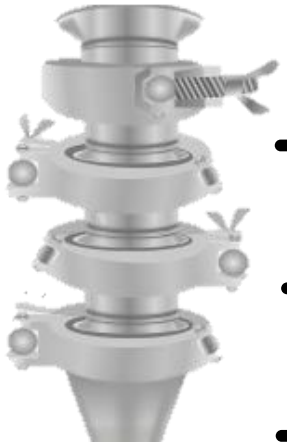
Second sampling campaign

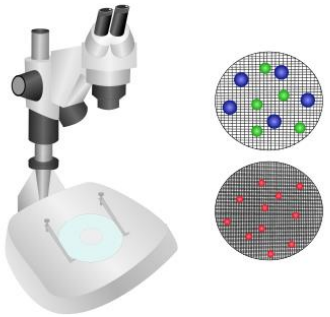
400 mL



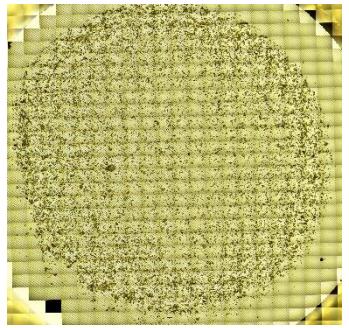
100 µm

10 µm

1 µm



Visual Analysis



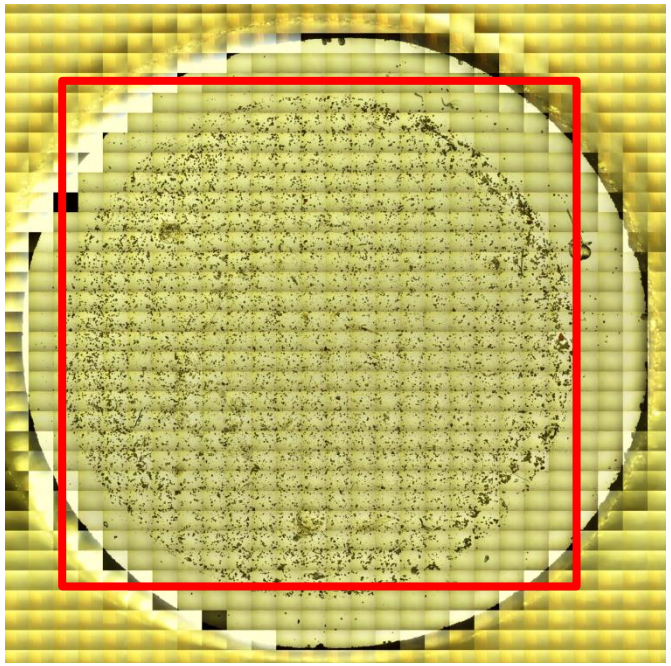
µFTIR

later

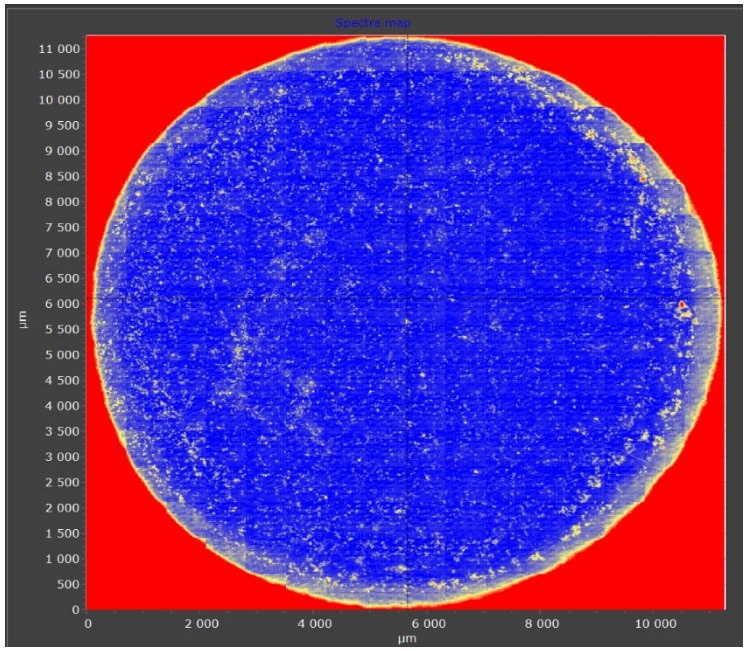
Precautions:

- All laboratory equipment is pre-cleaned.
- All reagents are filtered using 0.2 µm GF-filters.
- Handling of samples in LAF bench in a clean room with HEPA filter.

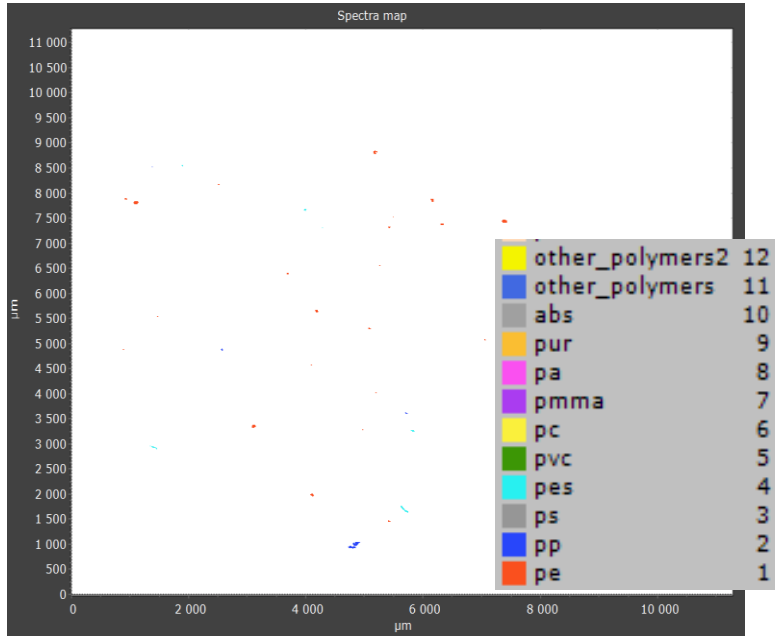
Particle identification and quantification



Visual image



Heat map of all particles on
13 mm silicium membrane filter



Map of only identified MP particles
(Note: MP < 2 pixels ignored)

Blanks and detection limits

Counts per sample	PE	PP	PES	PS	ABS	PA	PC	PMMA	PVC	PUR	Other polymers	Other rubbers		Total counts	Total mass (µg)
Lab-blank-A	0	3	3	1	0	0	0	0	0	0	0	0		7	0.042
Lab-blank-B	0	0	0	0	0	0	0	0	0	0	1	0		1	0.082
Field blank-A	3	3	2	0	0	0	0	0	0	0	0	0		8	0.061
Field blank-B	2	5	2	0	0	0	0	0	0	0	0	0		9	0.093
Average	**1.3**	**2.8**	**1.8**	**0.3**	**0**	**0**	**0**	**0**	**0**	**0**	**0.3**	**0**		**6.3**	**0.070**
SD	1.5	2.1	1.3	0.5	-	-	-	-	-	-	0.5	-		3.6	0.023

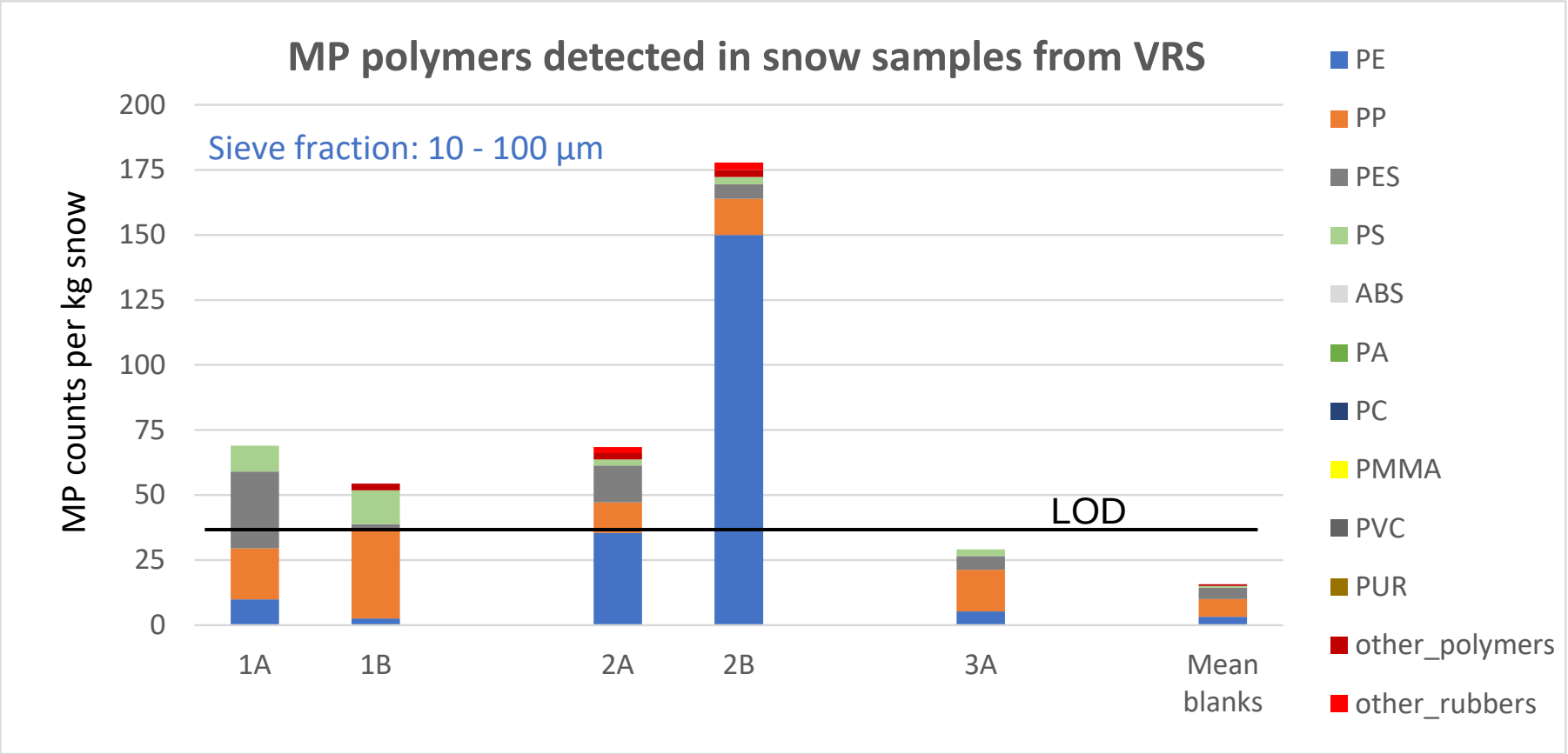
LODs	PE	PP	PES	PS	ABS	PA	PC	PMMA	PVC	PUR	Other polymers	Other rubbers		Total counts	Total mass (µg)
per 400 ml sample	5.8	8.9	5.5	1.8	<1	<1	<1	<1	<1	<1	1.8	<1		17.0	0.138
per kg snow	**14.4**	**22.3**	**13.8**	**4.4**	**<2.5**	**<2.5**	**<2.5**	**<2.5**	**<2.5**	**<2.5**	**4.4**	**<2.5**		**42.6**	**0.345**

Recommendations from EU MSFD and OSPAR: LOD = Mean + 3•STD

High detection limits due to blank variability

MP concentrations

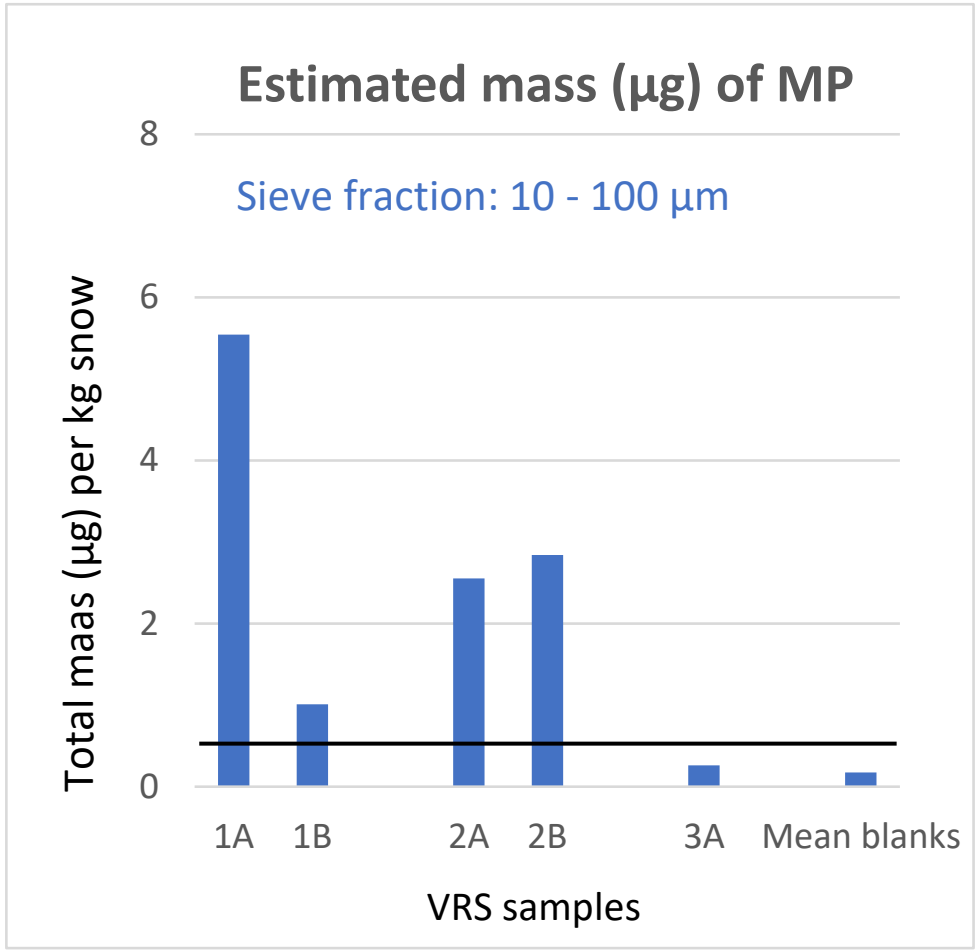
10-100 µm



Primary polymers: PE (58%), PP (18%), PES (16%), PS (5%), other (2%)

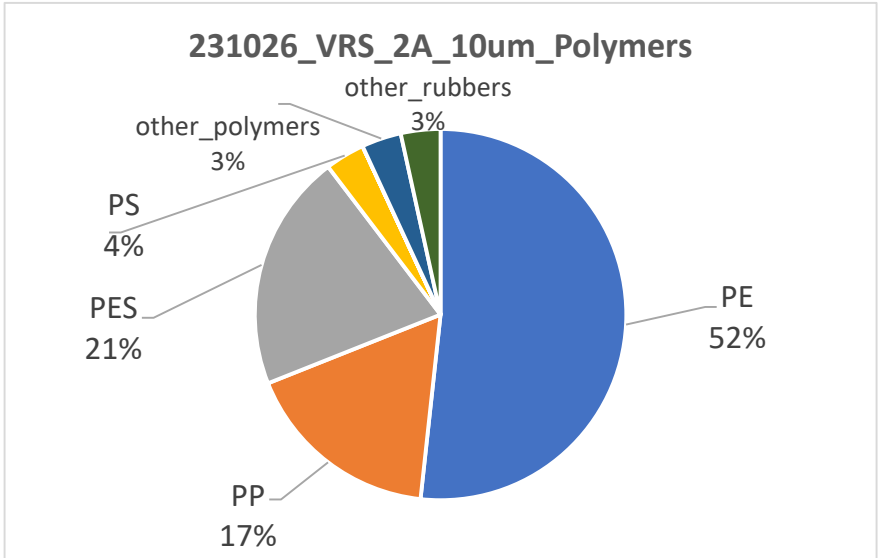
Results per mass

10-100 µm

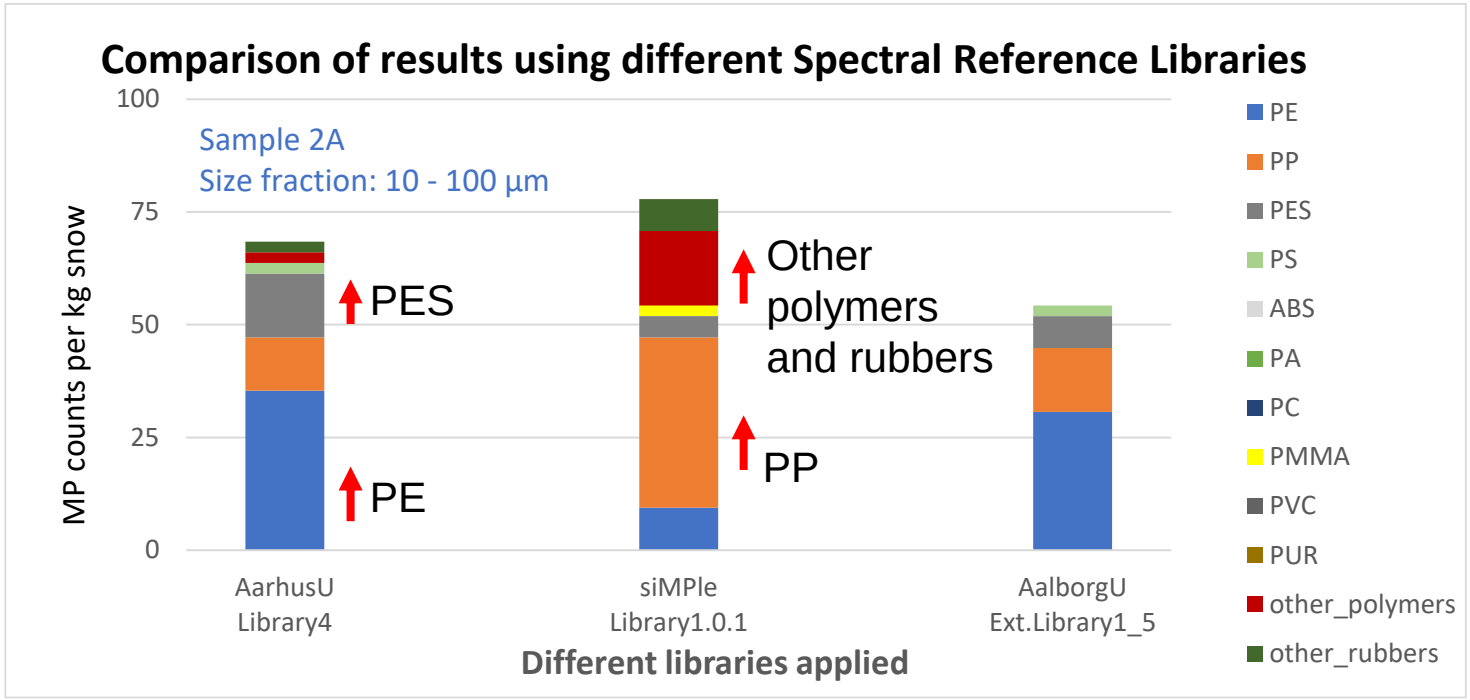


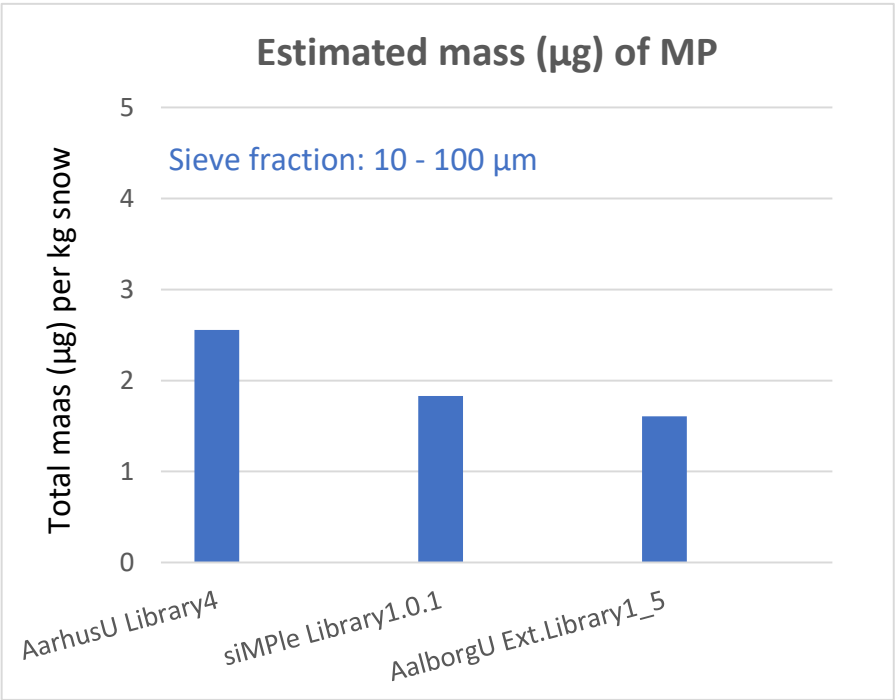
Composition

MP counts per kg snow	
PE	35
PP	12
PES	14
PS	2
Other polymers	4
Total counts	**67**
Total mass (µg)	2.55



The issue of spectrum libraries





Amounts are comparable, but composition is not.

Conclusions

Microplastics are detected in Greenland snow. Long-range atmospheric transport to the Arctic is happening.

QA/QC needs emphasis and would benefit from more standardization, incl. definition of detection limits.

The way towards monitoring should address air vs. deposition measurements and the limitations/possibilities of using existing programmes.

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