Atmospheric Microplastic in the Arctic and the Norwegian mainland

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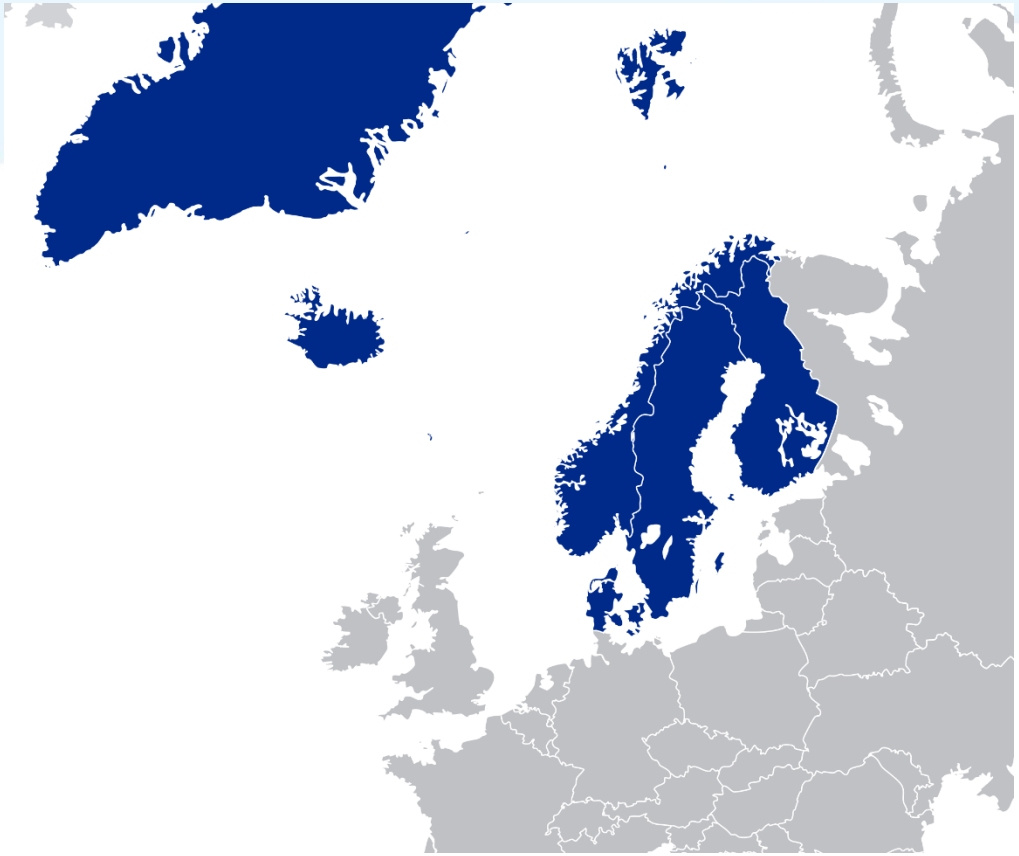
NILU Norsk institutt for luftforskning

Why?

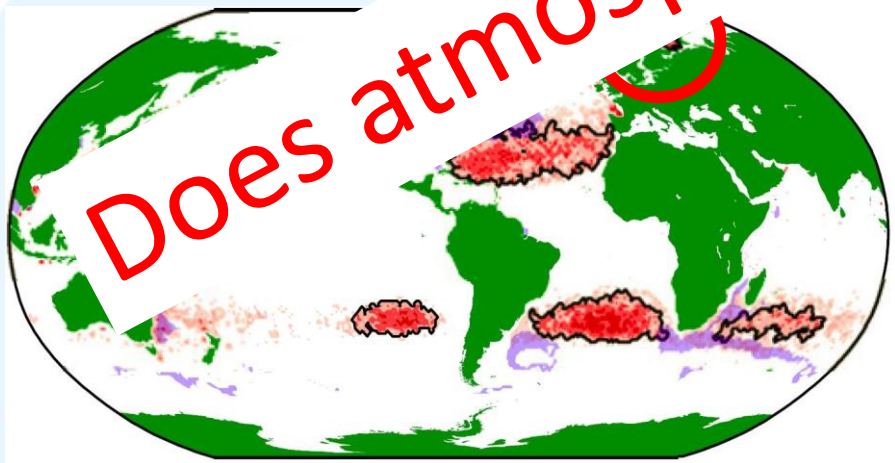
1. Investigate the role of MP and other related chemicals in atmospheric and deposition samples to global distribution
2. Improve sampling and sample treatment methods
3. Apply advanced modelling tools for source and transport elucidation



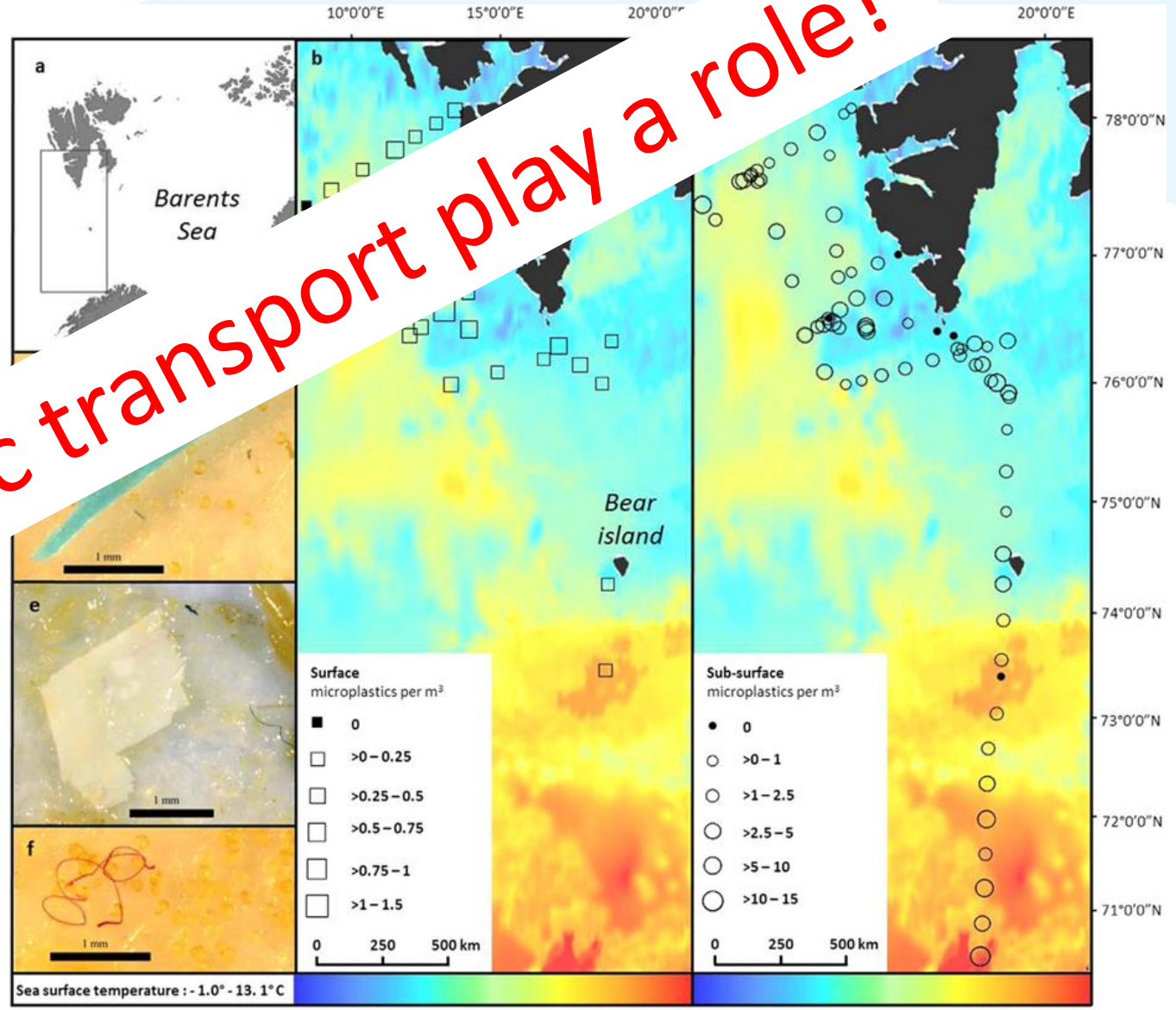
What do we already know?
How much plastic is present in the Arctic?

Seawater

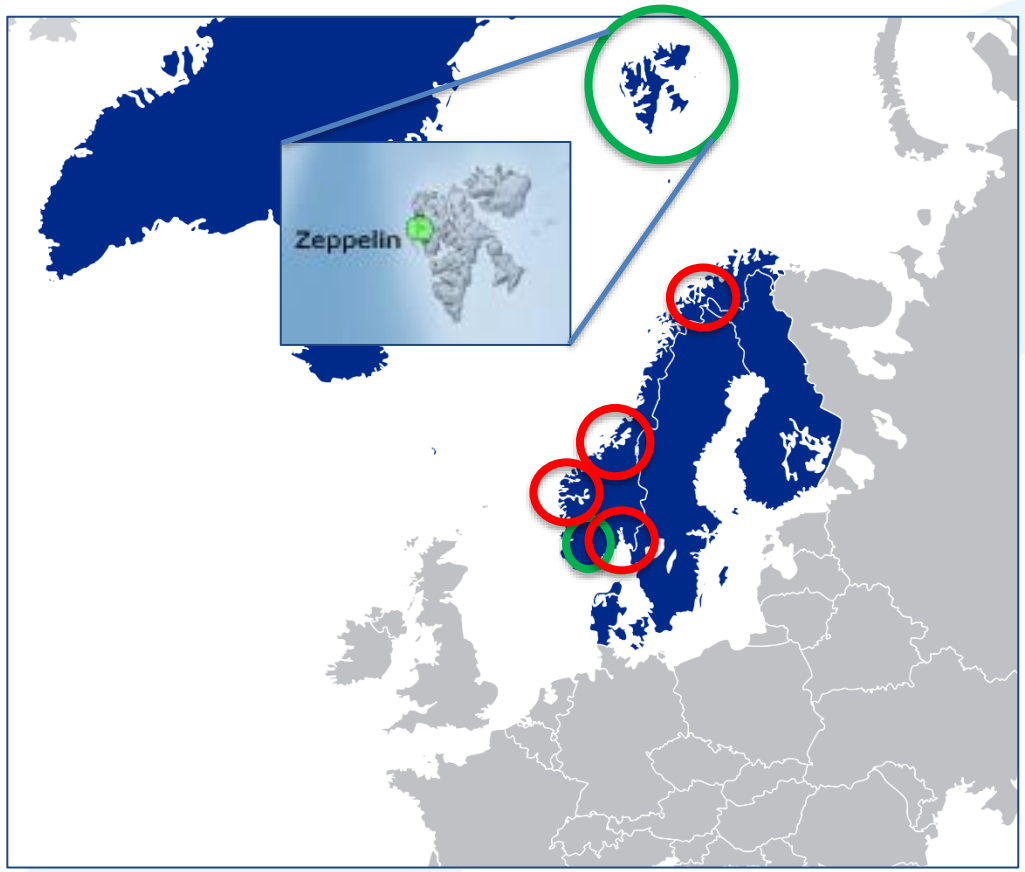
- 0 – 11.5 particles m^{-3} (Lusher et al. 2015)
- 0.004 (Barents Sea) and 0.006 (Fram Strait) items km^{-1} floating plastic (Bergmann et al. 2016)
- Modeling study: a sixth garbage patch may be forming in the Barents S… (van Sebille et al. 2012)



Does atmospheric transport play a role?



Sampling sites Svalbard and Norwegian mainland



- Svalbard, a Norwegian archipelago in the Arctic Ocean → air quality monitoring station
- Situated north of mainland Europe, it is about midway between continental Norway and the North Pole (from 74° to 81° north latitude)
- Longyearbyen is the largest settlement on the archipelago (Pop. of about 2000)

- Trondheim, Tromsø, Oslo, Bergen urban

- Birkenes, air quality station, remote

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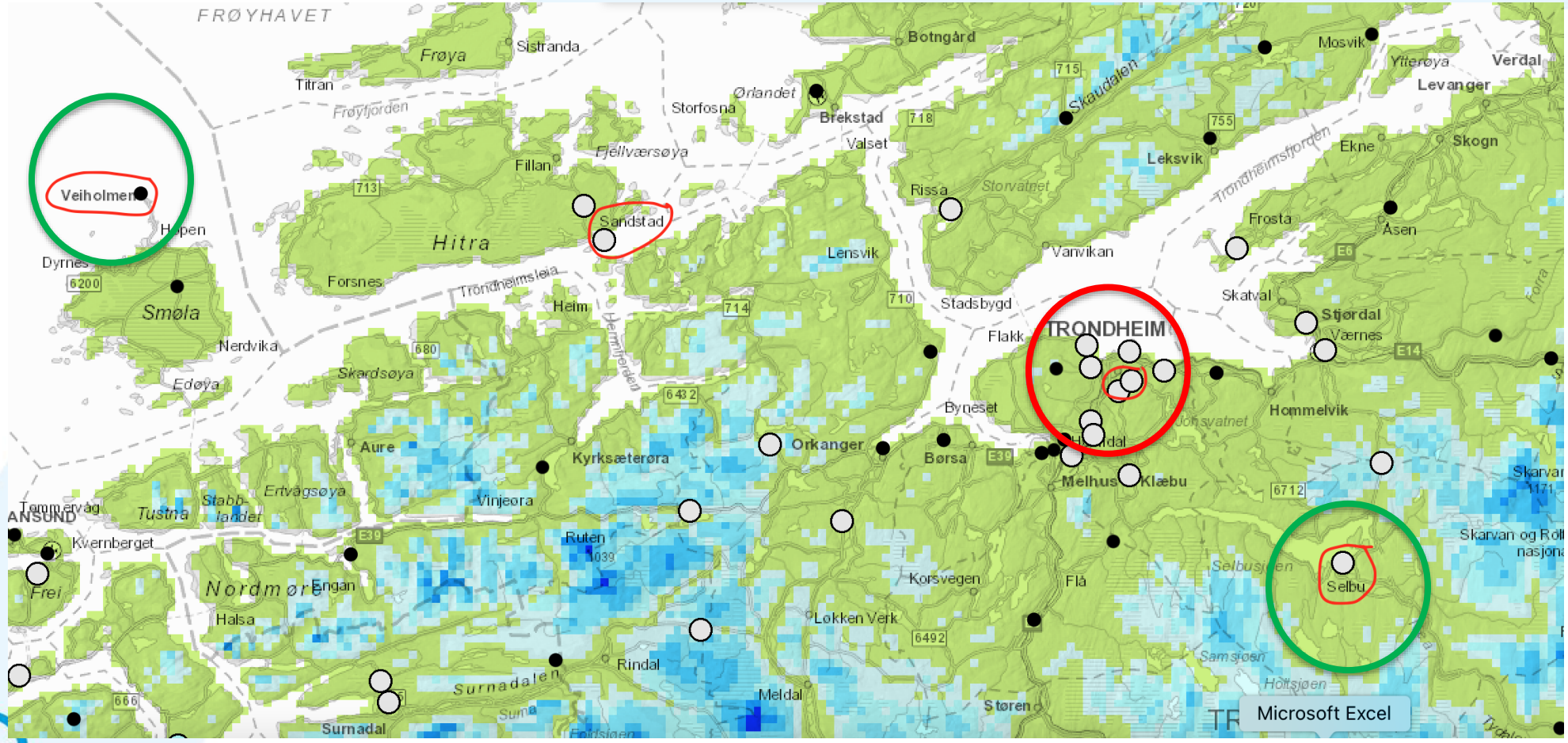
Urban samples – city of Trondheim, only deposition samples



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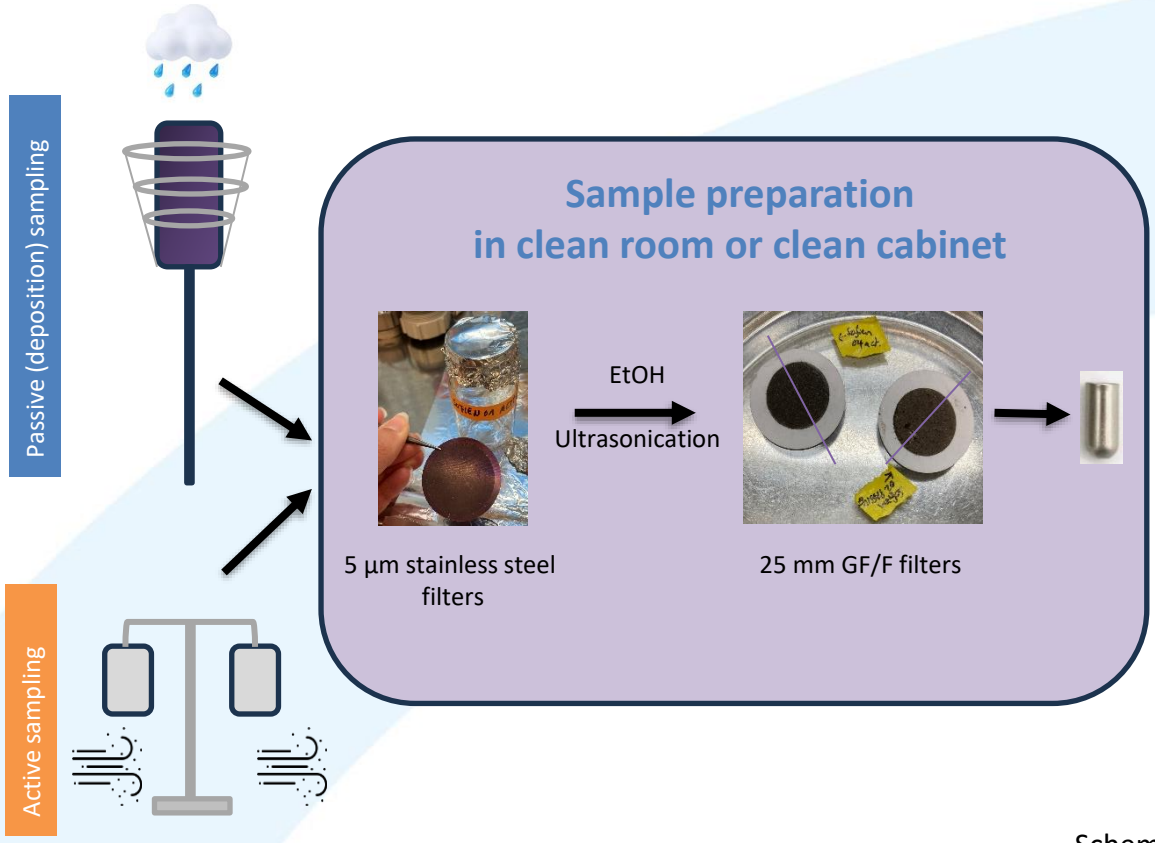
Sampling

- From June to December 2022
- 14 days of sample collection per sample both for active and deposition sampling → Shown data are preliminary
- Approx. 1000 m3 sampled by active sampling
- All metall, pre-cleaned devices used

Sample treatment of active and deposition samples



pyrolysis

FrontiersLab micro-furnace pyrolyzer EGA/Py-3030D

Schematics by N.Schmidt

QA/QC: blank samples from all steps including field blanks,

All samples were batchwise blank corrected (Average blank + 2 x STDEV)

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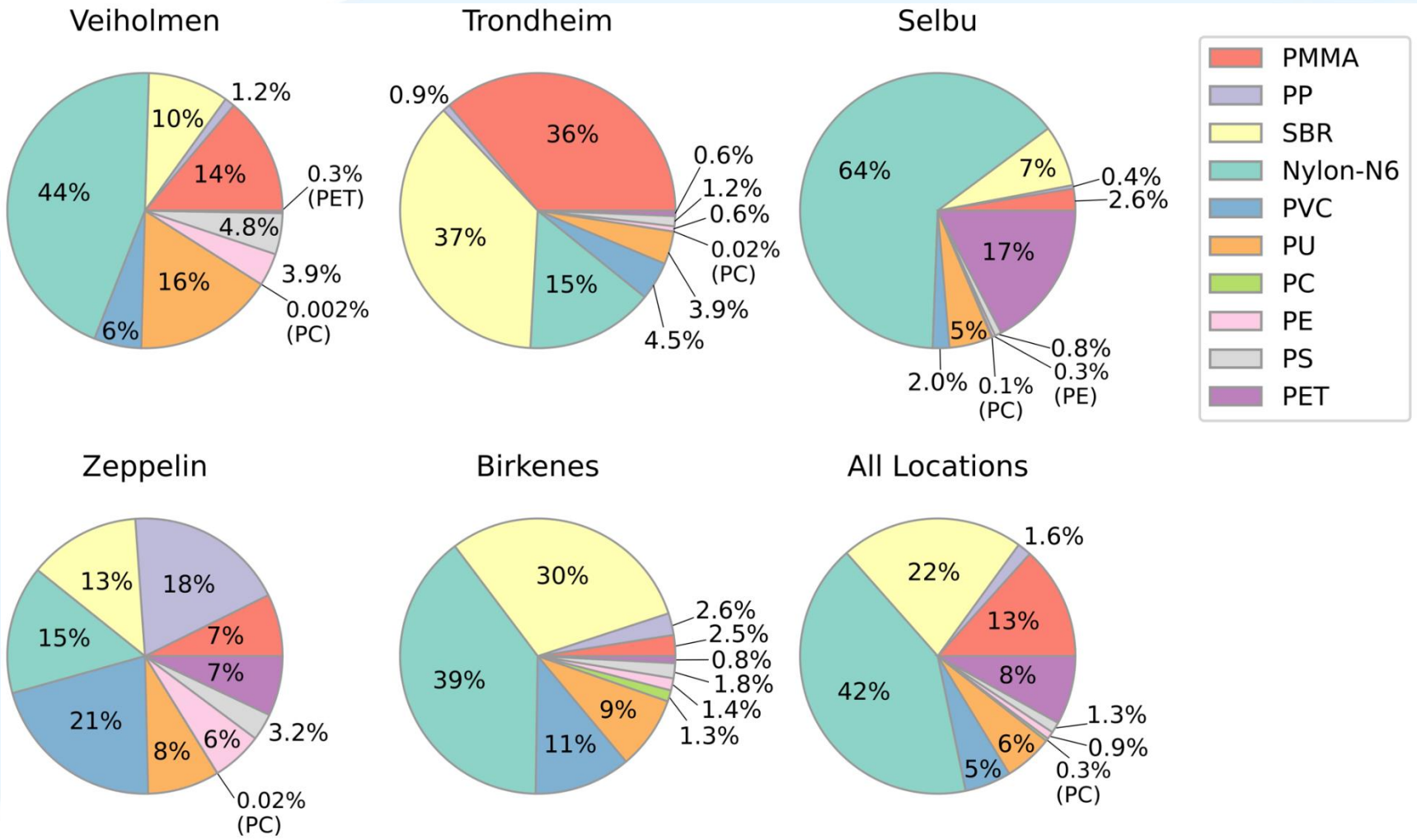
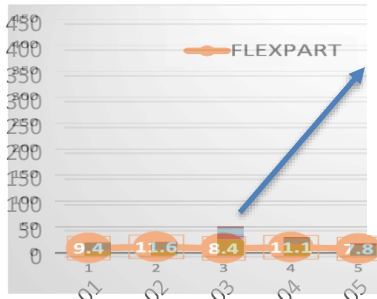
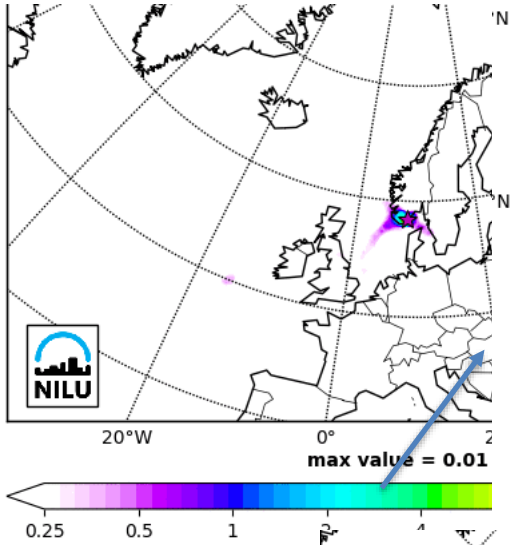
Distribution of MP polymer types in deposition samples

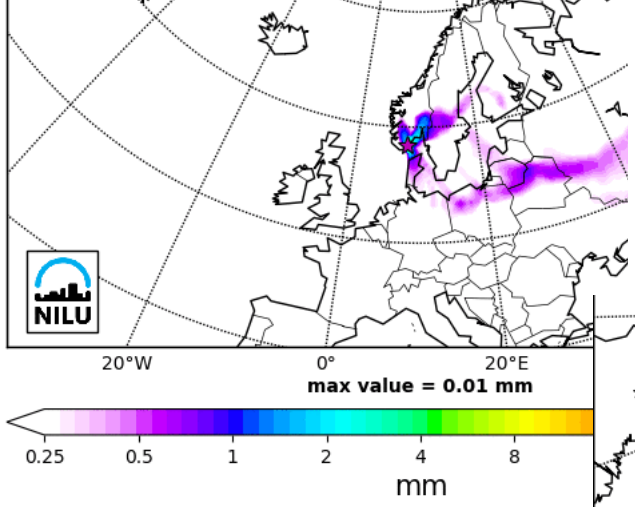


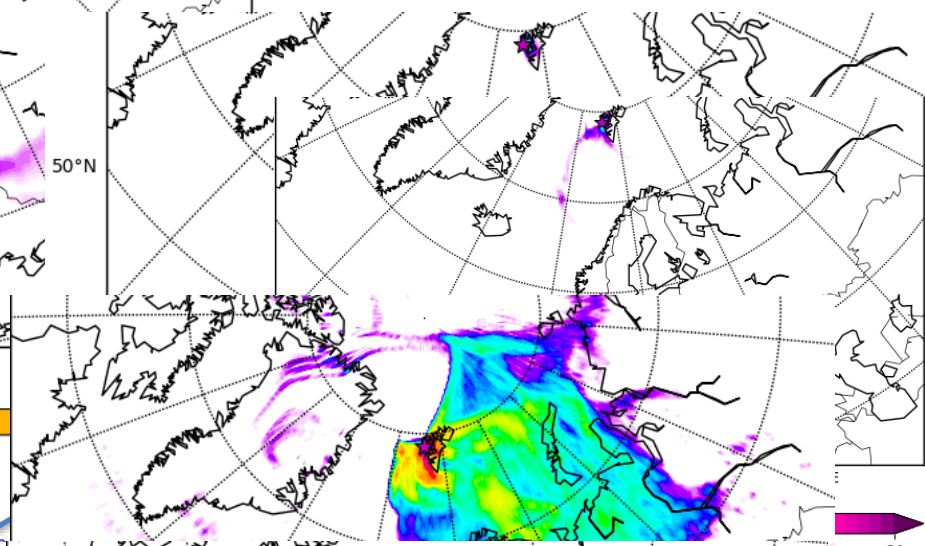
Results f

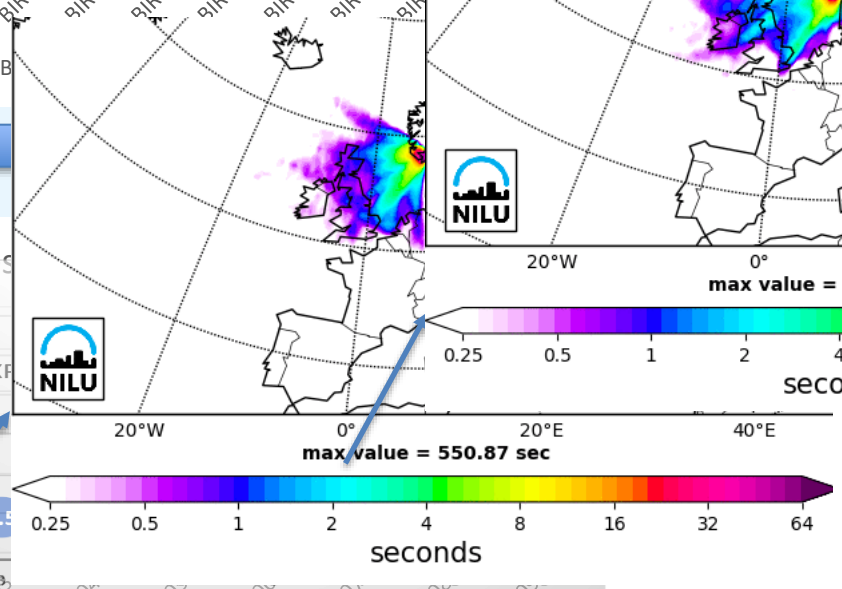
Birkenes; MP i

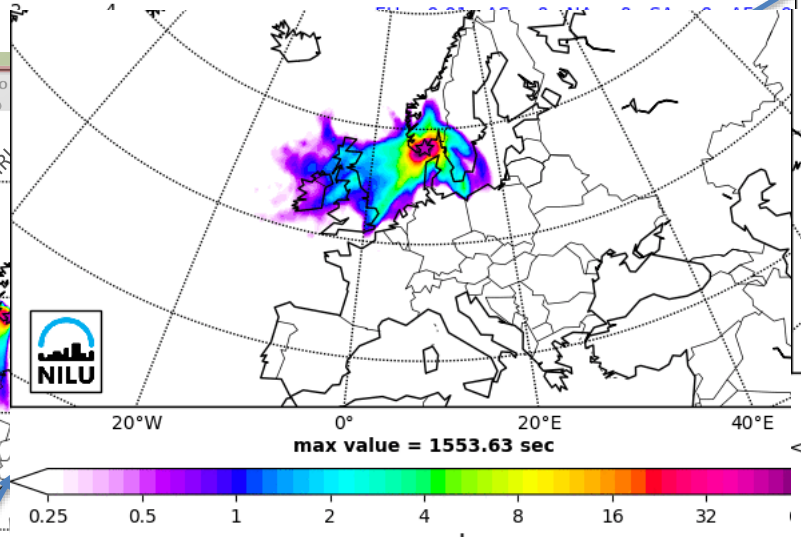


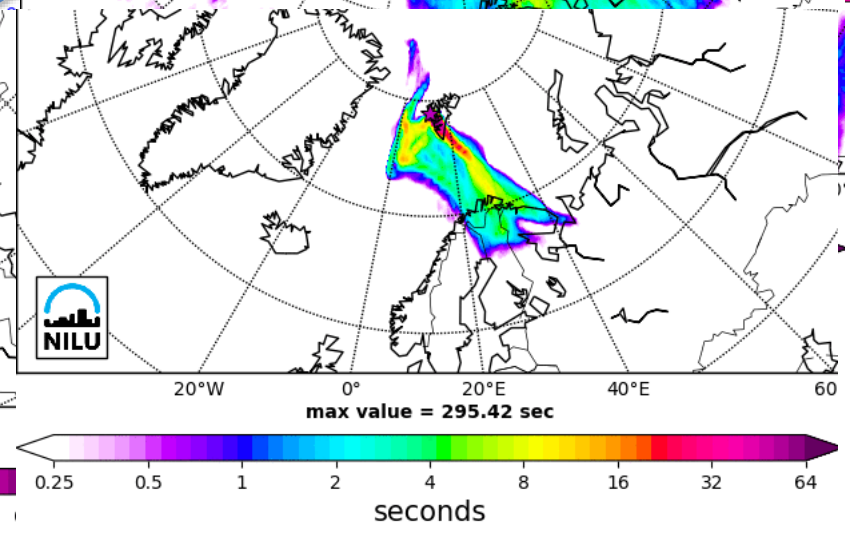


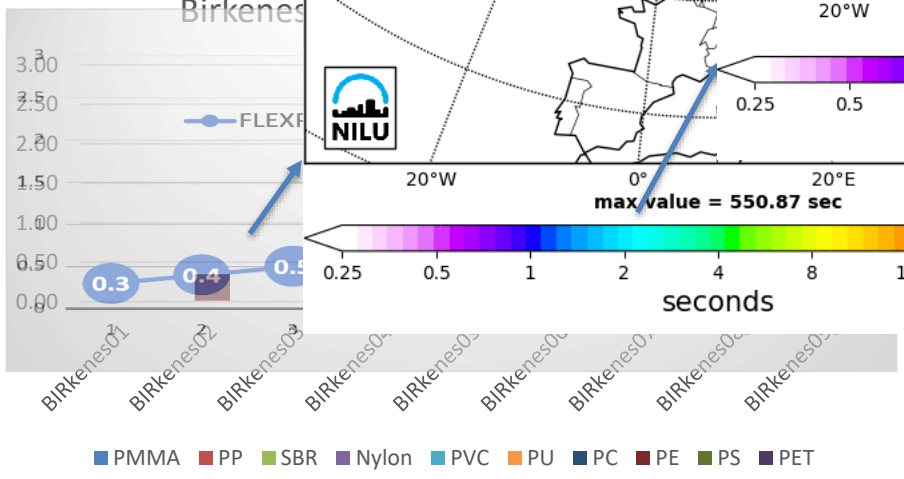


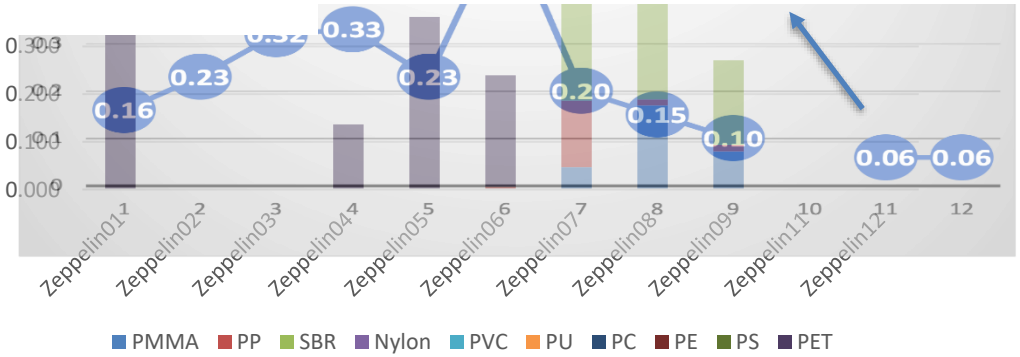




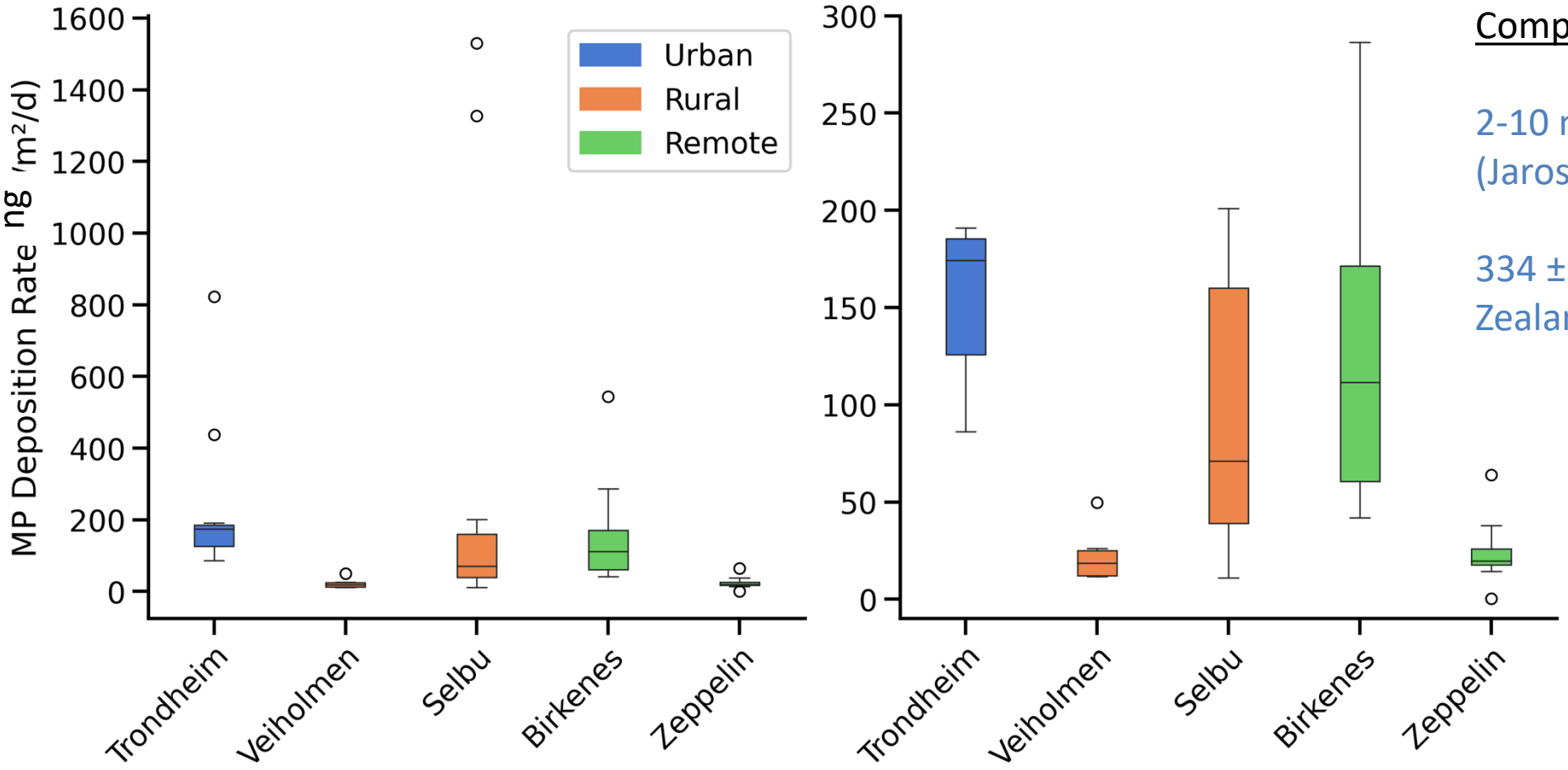








Deposition rates

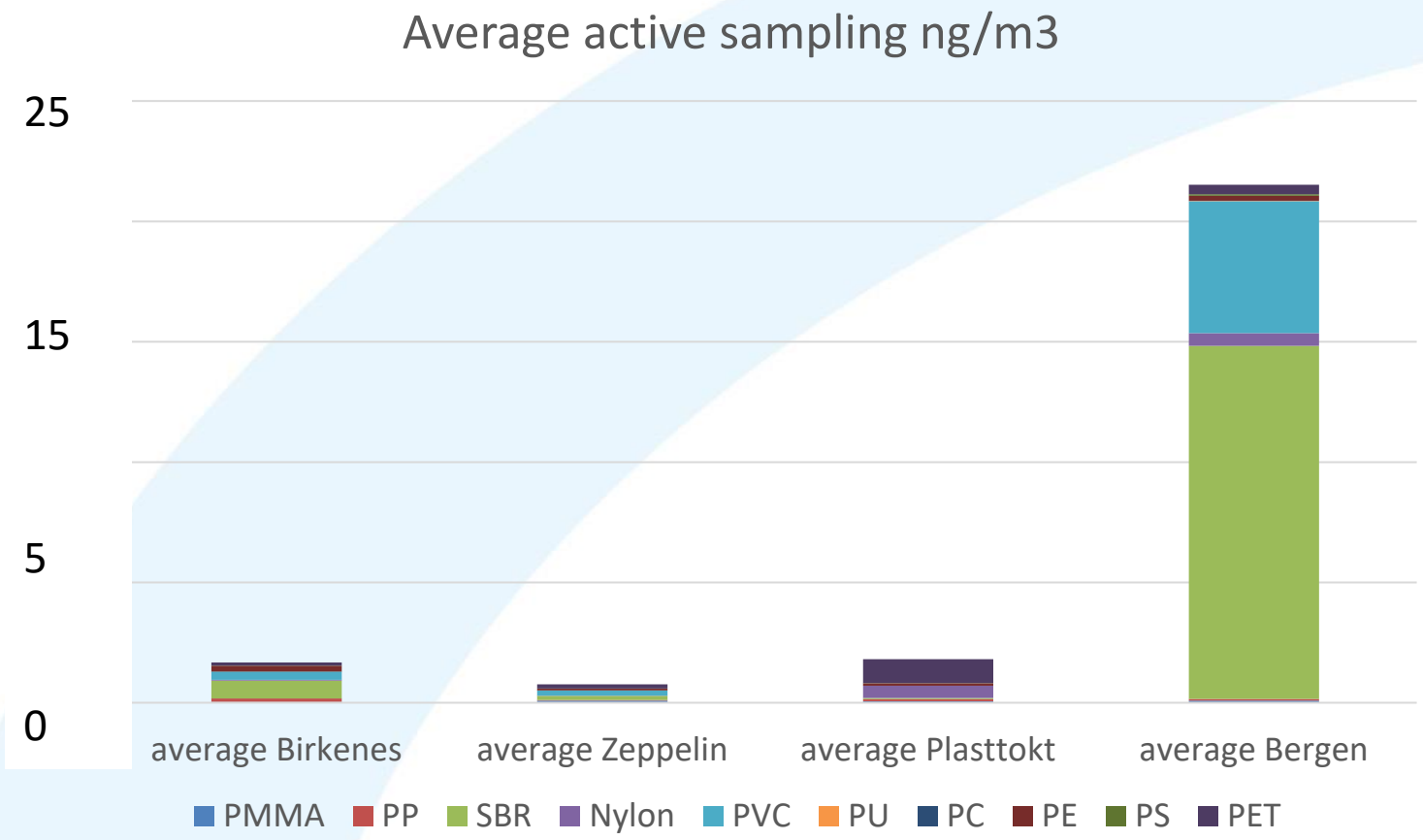


Comparison with literature data:

2-10 mg/m^2/d Krakov, Poland, 2019 (Jarosz et al., 2022)

334 ± 81 µg/m^2/d Auckland, New Zealand, 2020 (Fan et al., 2022)

MP in air; comparison of active samples



- SBR and PVC dominate, but not at sea around Svalbard

- Urban samples are 12-times higher compared to reference sites

Max. 37.5 ng/m^3 along Norwegian coast (Gossmann et al., 2023)

Mizuguchi et al. (2023): PP, PS and SBR in the lower ng/m^3 range in active air samples from Tokushima (Japan)

Conclusion

- First report on MP in wet/dry deposition in combination with sampling of suspended atmospheric particles
- MP can be detected in wet/dry deposition as well as in suspended particles (active sampling)
- MP composition varies between locations
- MP composition changes over the seasons
- Impact of wind direction and wind speed in some regions
- Modelling shows underestimation →missing sources?

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Thank you for your attention

We thank PlastPoll21, FACTS and the Norwegian Environmental Agency for funding
H.P.Arp for co-supervision

FACTS

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For further questions please contact dorte.herzke@nilu.no

Polymer name	Acronym	Pyrolyzate	Inst. LOD	LOQ
			ng	µg
Poly(methyl methacrylate)	**PMMA**	methyl methacrylate	0.03	0.05
Polypropylene	**PP**	2,4-dimethyl-1-hepten	0.18	0.69
Styrene-butadiene rubber	**SBR***	2,4-dimethyl-4-vinylcyclohexene	0.08	5.52
Polyvinylchloride	**PVC**	naphthalene	0.21	3.55
Polyamide/ Nylon	**Nylon**	caprolactam	0.02	0.00
Polyurethane	**PU**	cyclopentanone	0.01	0.01
Polycarbonate	**PC**	bisphenol A dimethyl ether	0.03	0.00
Polystyrene	**PS**	PS-trimer	0.03	0.06
Polyethylene terephthalate	**PET**	dimethyl terephthalate	0.73	0.24
Polyethylene	**PE**	C18:2 alkene	0.14	0.00

*quantification of SBR using an ANDROMEDA standard made of 20 different tyres and well characterized (Foscari et al., 2023)

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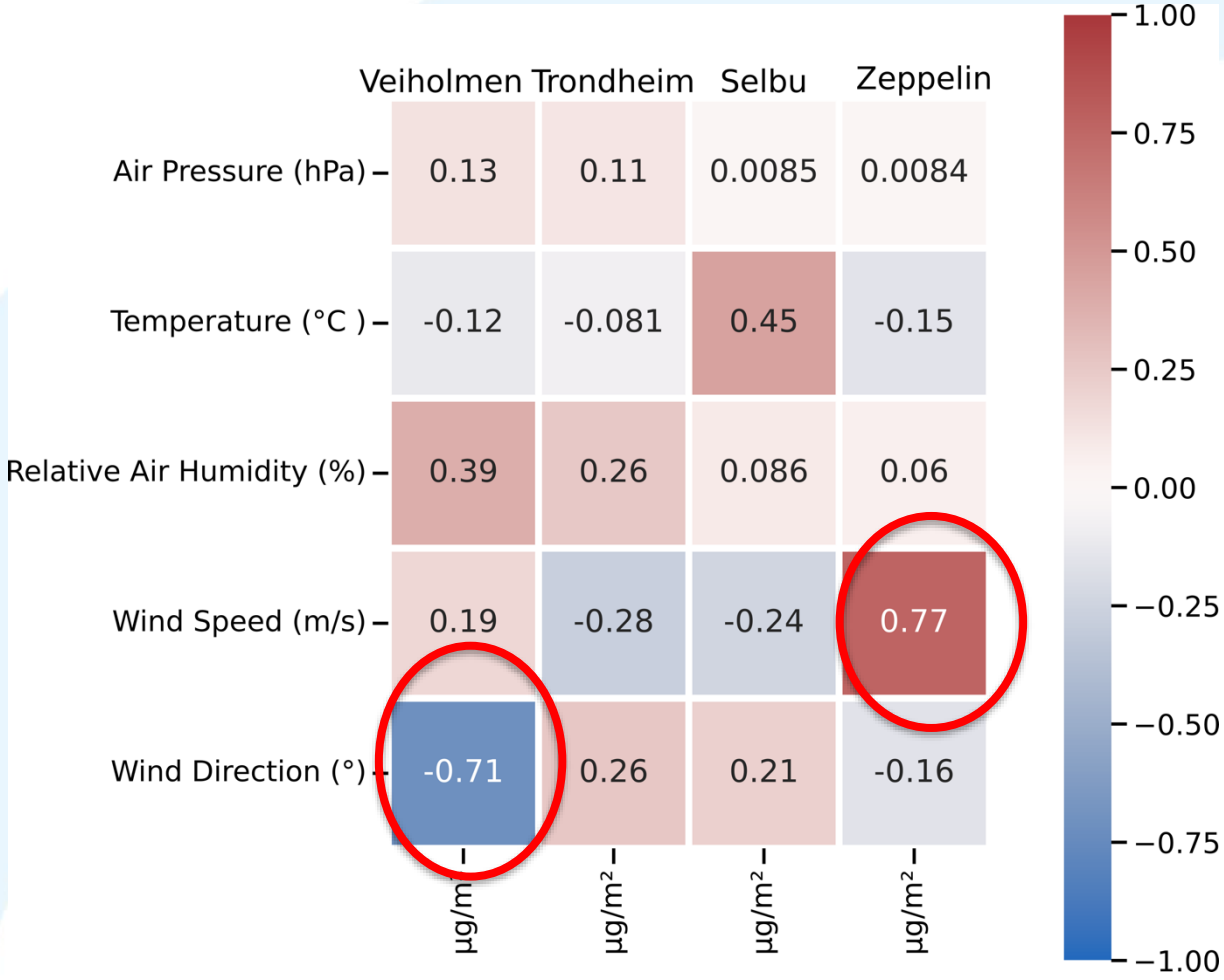
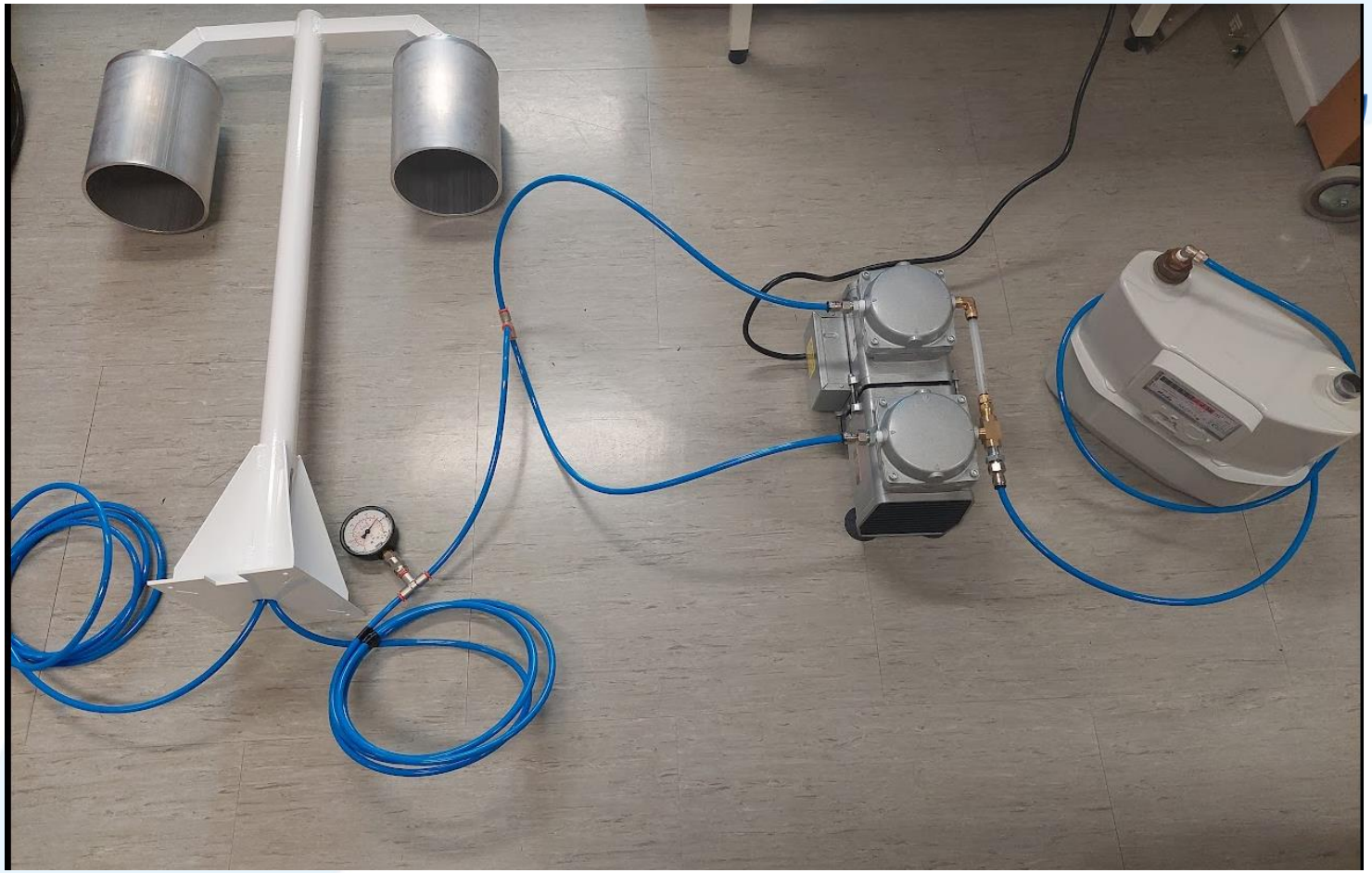
Correlation with Metereological parameters

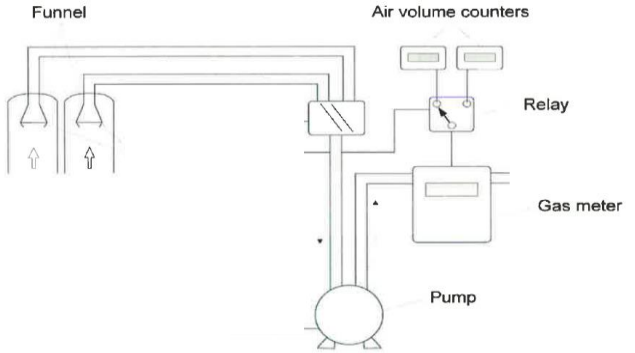


1) High wind speeds at Zeppelin mountain are positive correlated with MP concentrations

2) Specific wind directions are negatively correlated with MP concentrations at Veiholmen (wind from the ocean)

NILU active sampler set up





5 µm pre-burned steel filters used