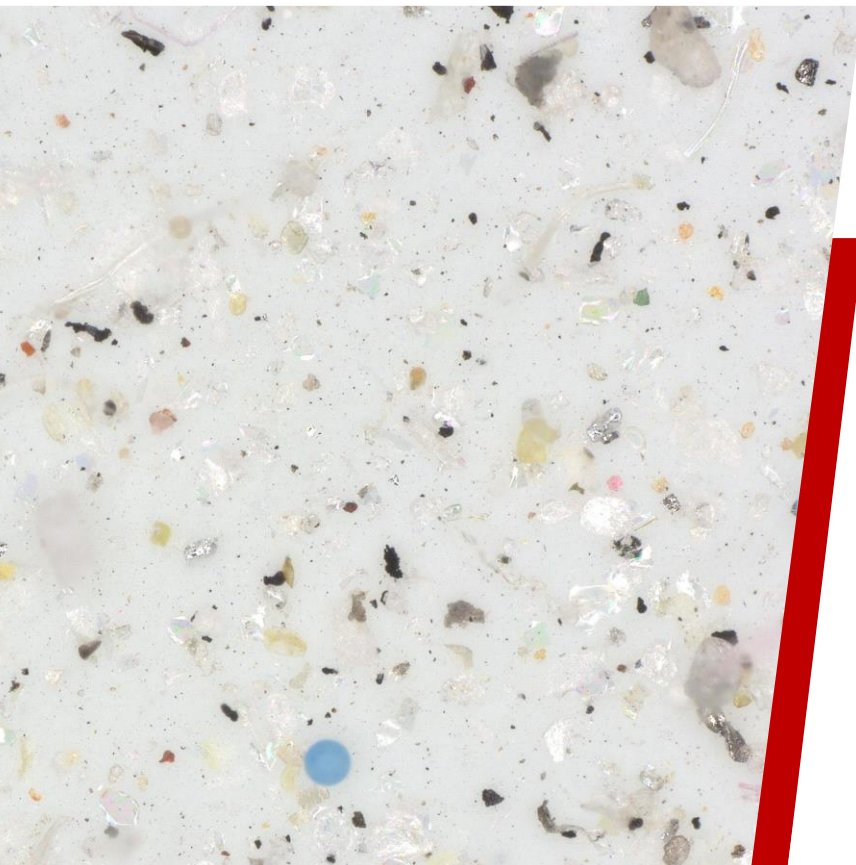




Atmospheric deposition of microplastics and tire wear in Switzerland

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28-29.04.2026, 27th EMEP TFMM Meeting, Bled

What are microplastics (MP)?



MP = water-insoluble **plastic particles** < 5 mm and > 1 μm in their longest dimension

Primary MP

intentionally produced for industrial and commercial uses (e.g. plastic production, cosmetics)



Secondary MP

unintentionally generated e.g. from breakdown of larger plastics or released from synthetic textiles

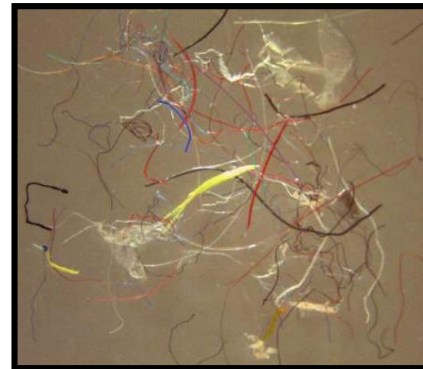


Image source: Harpeth Conservancy

Why are we concerned about MP in the environment ?



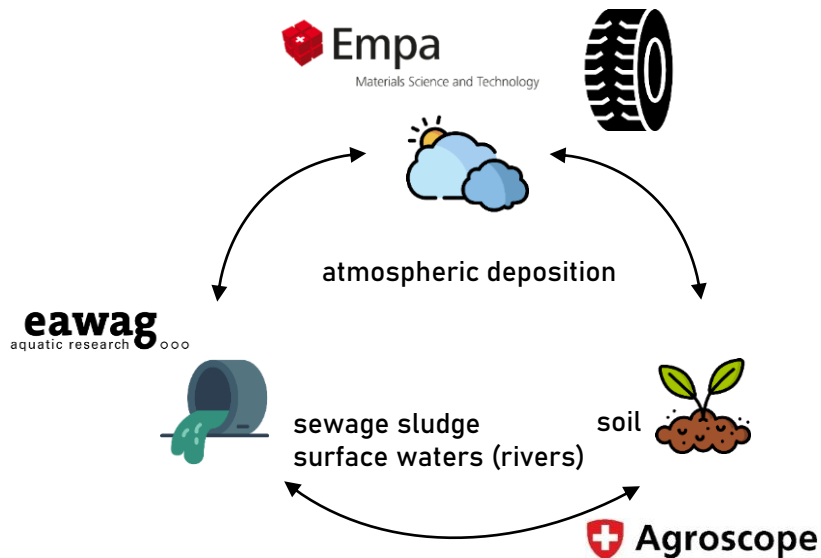
- Persistent in the environment (non-biodegradable + stabilized by additives)
- Transported far from point of release by air and water currents
- Transferred between land ↔ sea, air ↔ land, air ↔ water
- Found ubiquitously in the environment, including in the Arctic
- Adverse health effects: reduced feeding stimulus in small organisms, physical damage, oxidative stress, inflammation + potential hazards from plastic-associated chemicals

Terminology used: MP for synthetic polymers except tire wear, TWP for tire wear particles

Parallel projects on microplastics analytics



Project on atmospheric deposition of tire wear (funded by the **Swiss Federal Roads Office FEDRO**) 8/2023 – 6/2026

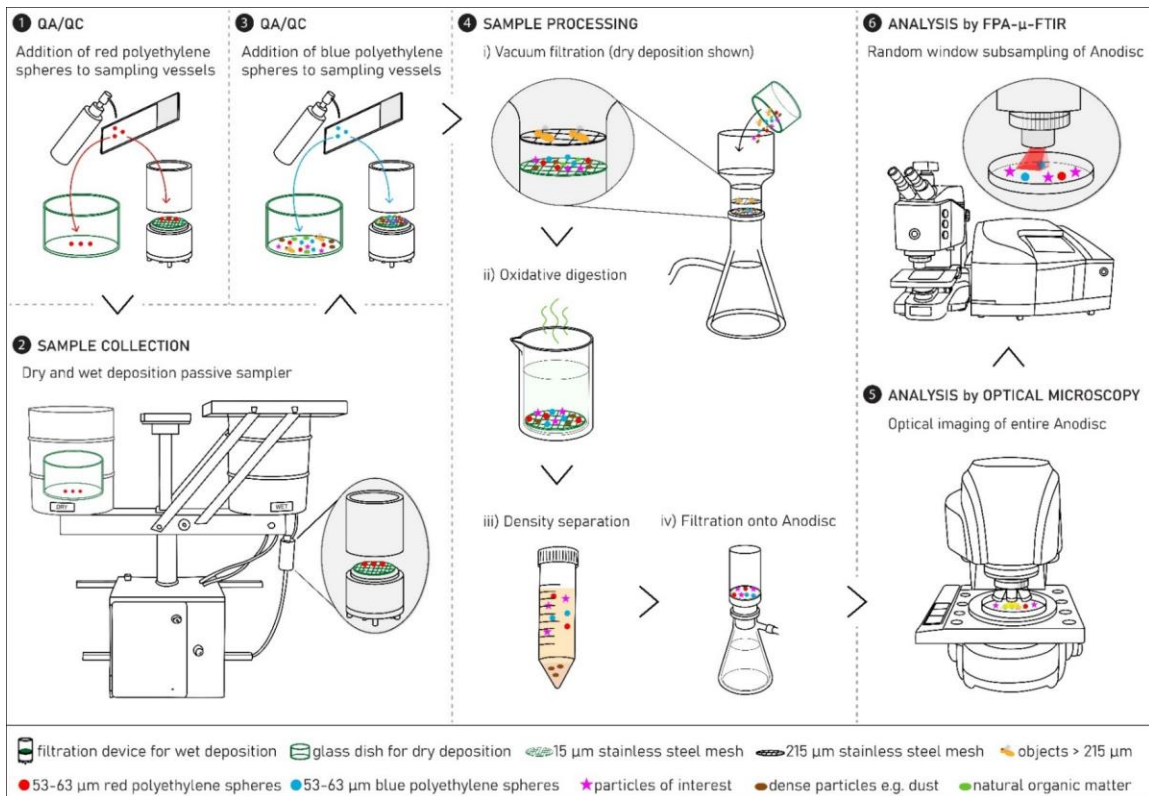


Projects funded by the
Swiss Federal Office for the Environment
(FOEN) 3/2022 – 2/2026

Goals of atmospheric deposition project:

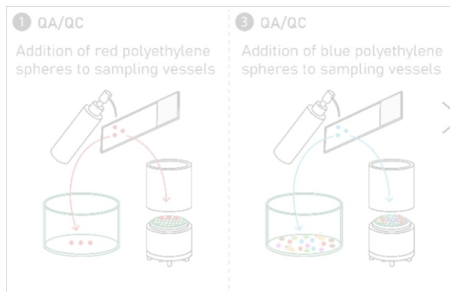
- Develop **harmonized method** for measuring MP across different environmental compartments (atmosphere, sewage sludge, water and soil)
- Monitor **wet & dry atmos. deposition** of MP across Switzerland
- Determine the types and amount of MP entering the environment via the atmosphere in Switzerland (incl. tire wear particles, TWP)

Quantifying MP in atmospheric deposition samples



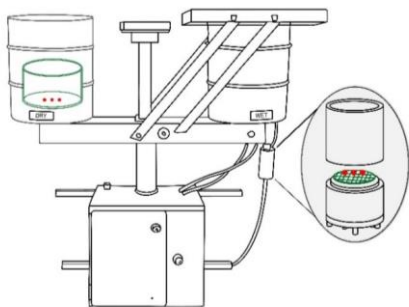
Ashta et al., AMT 2026

Analytical workflow - sample collection



2 SAMPLE COLLECTION

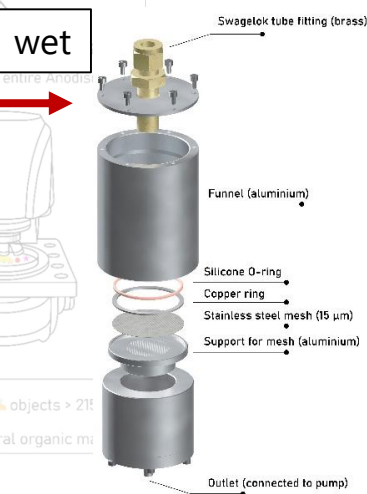
Dry and wet deposition passive sampler



Passive sampler for
collecting
dry and wet deposition

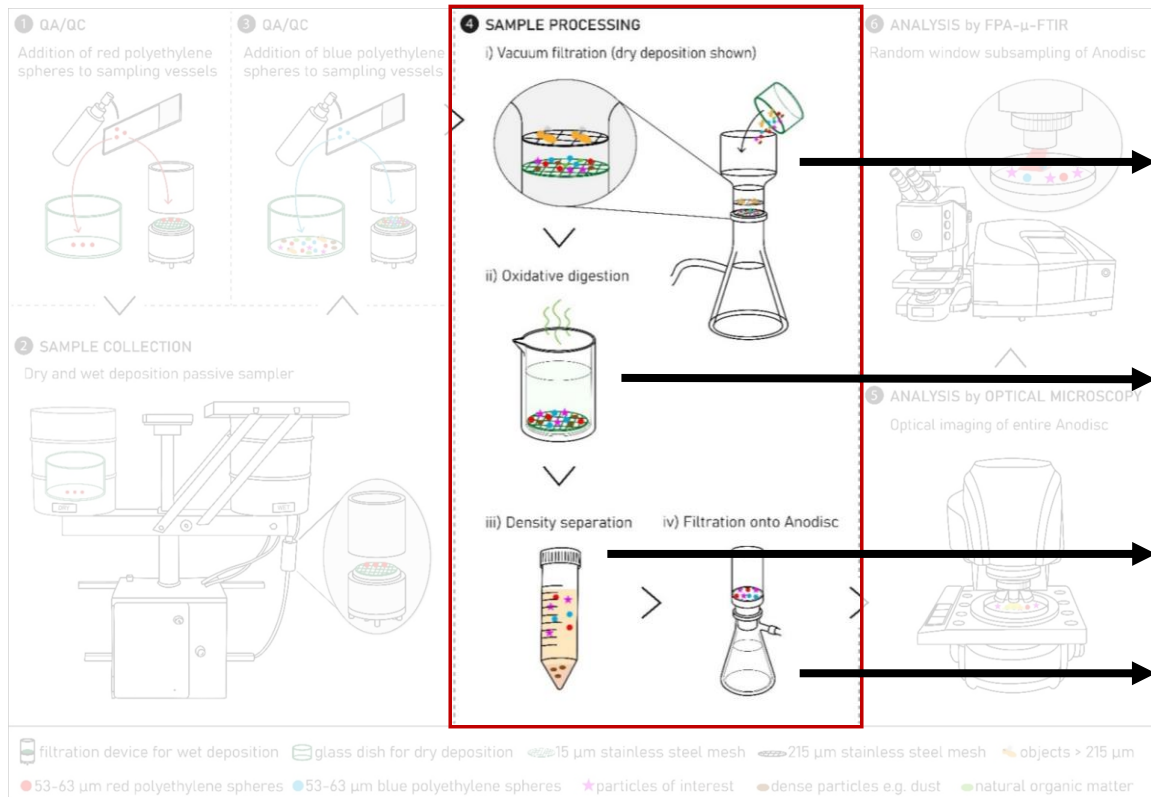


Glass bowl with
100 mL glycerol
as particle trap

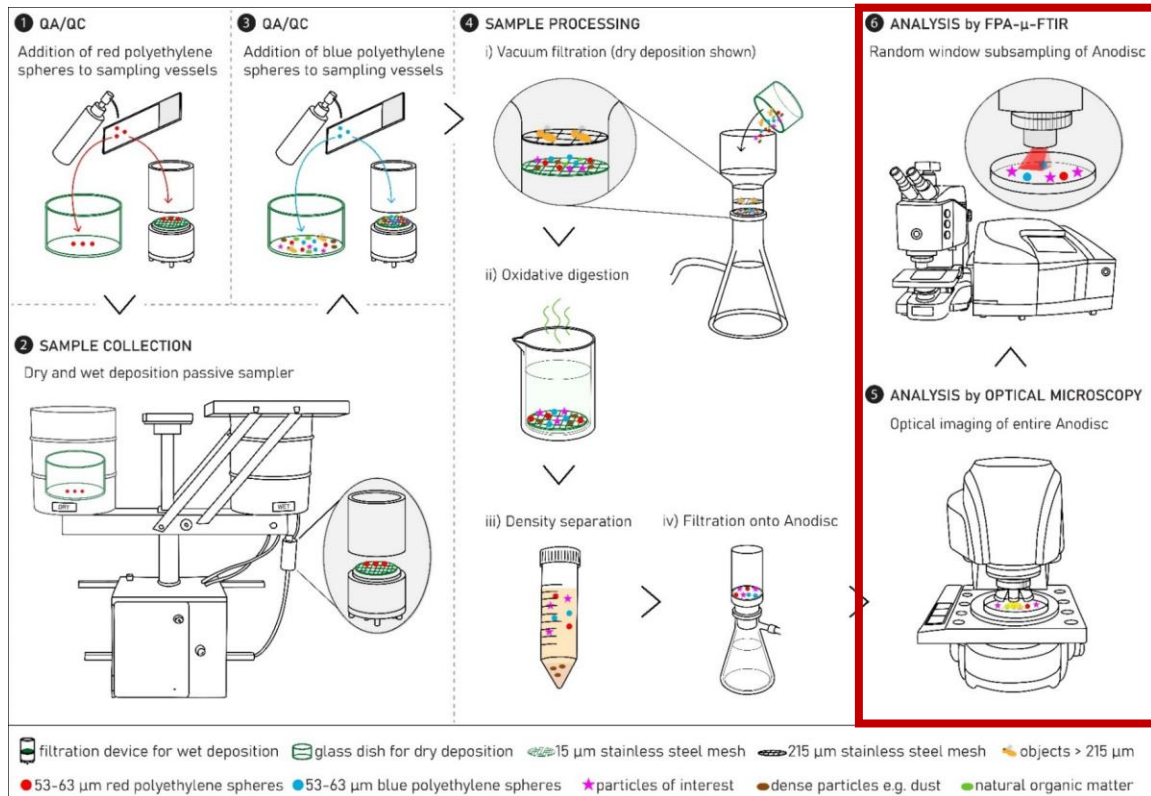


Custom made
filtration device
fitted with a 15
 μm stainless
steel mesh to
collect
particulate wet
deposition

Analytical workflow - sample processing steps

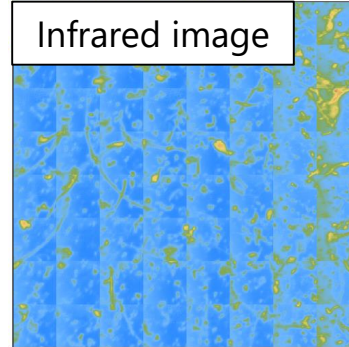


Analytical workflow → identification of MPs via *FPA-μ-FTIR spectroscopy

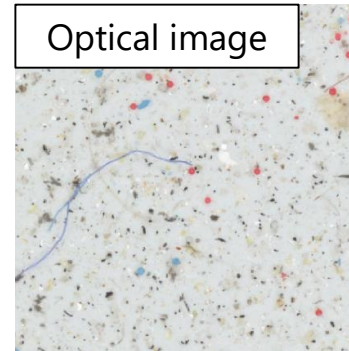


*focal plane array μ-Fourier transform infrared

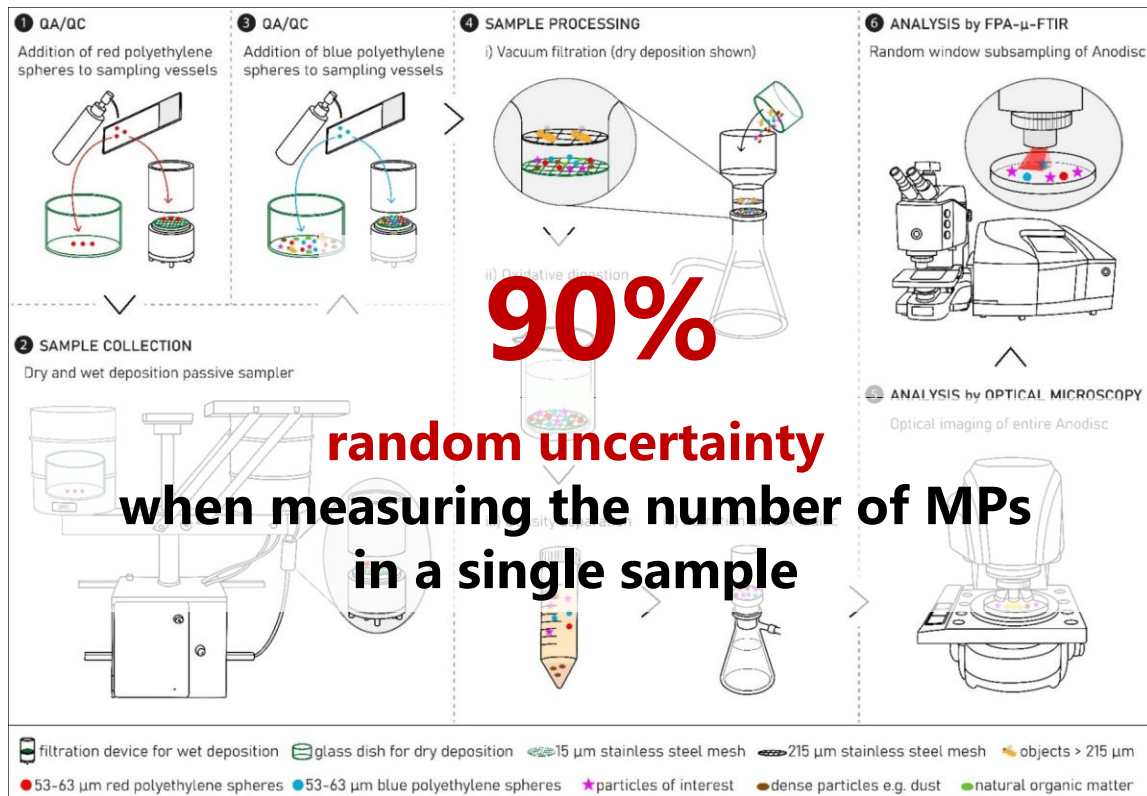
Infrared image



Optical image



Analytical workflow → total measurement uncertainty



Component of uncertainty	Standard uncertainty
Recovery of surrogate MPs (L1)	19 %
Repeatability of FPA-μ-FTIR measurements (L1)	5 %
Impact of filter topography/differential MP sizes on FPA-μ-FTIR results (L1)	24 %
Subsampling error associated with FPA-μ-FTIR (L1)	26 %
Assignment of experimental spectra (L1)	17 %
Sampling representativeness (L2)	23 %
Conversion of particle dimensions to mass (L3)	50 %

One-year field monitoring of the deposition of MP and tire wear in Switzerland



- Selected sites of Swiss National Air Pollution Monitoring Network
- Urban, ZUE (Zürich-Kaserne)
- Suburban, DUE (Dübendorf-Empa)
- Rural, PAY & MAG (Payerne & Magadino-Cadenazzo)
- Mountainous, CHA (Chaumont, 1140 m asl)



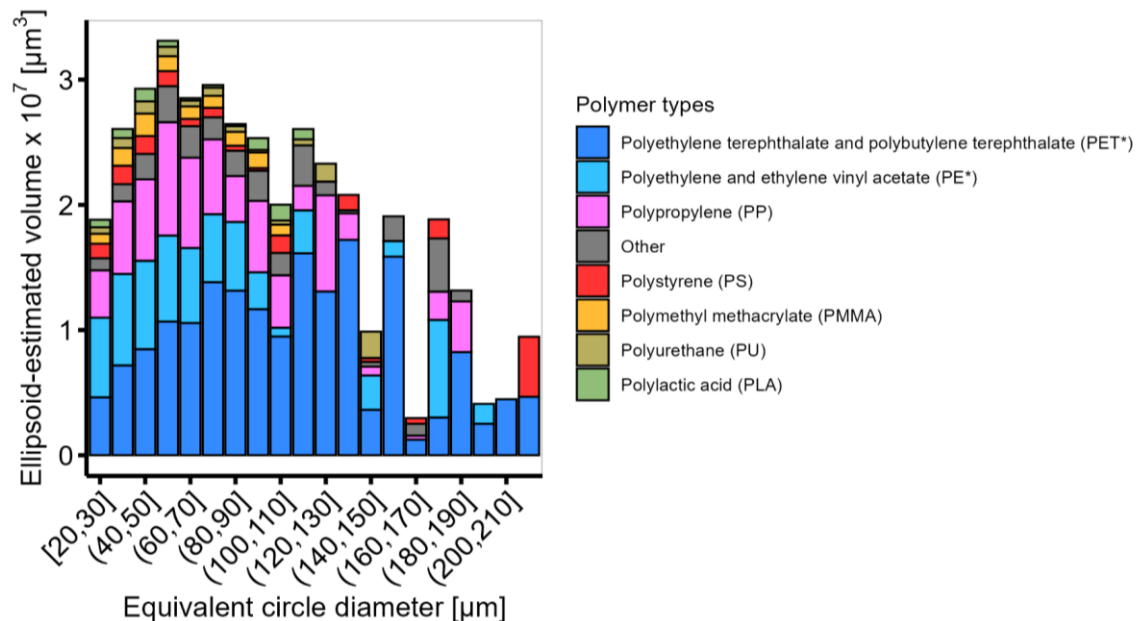
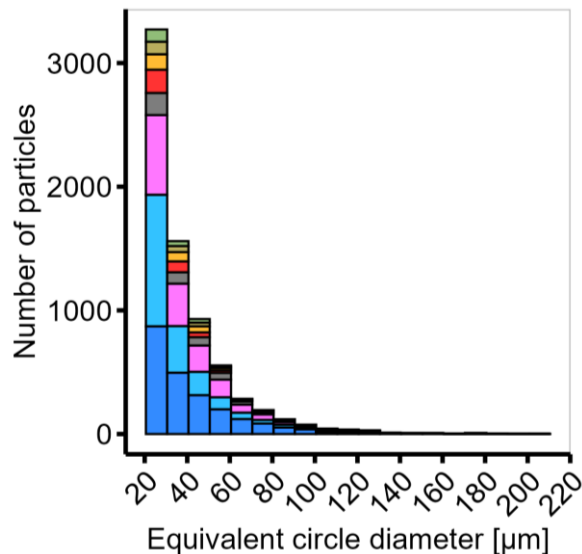
Magadino-Cadenazzo

Bulk (Wet&Dry) deposition sampler for quantification of tire wear particles (TWP) in atmospheric deposition using a method based on Pyrolysis-GCMS

Rahman et al. (in prep)

Monitoring period: May 2024 – May 2025.
Samples collected every four weeks

Particle sizes of microplastics found in atmospheric deposition samples

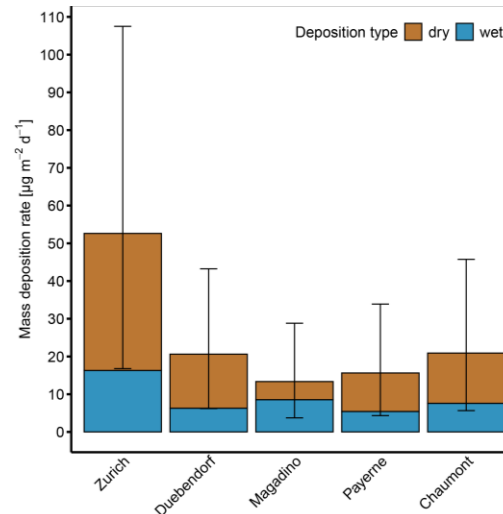
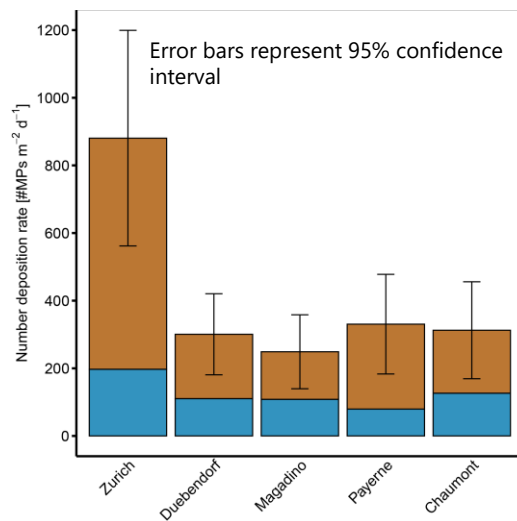


Deposition rates of MP in different parts of Switzerland



Site	Number deposition rates (#MP·m ⁻² ·d ⁻¹) [95%-CI]			Mass deposition rates (µg·m ⁻² ·d ⁻¹) [95%-CI]		
	Wet	Dry	Total	Wet	Dry	Total
Zurich	198 [145-249]	683 [514-853]	881 [562-1199]	16 [6-31]	36 [14-68]	53 [17-107]
Duebendorf	110 [79-142]	190 [137-244]	301 [181-420]	6 [2-12]	14 [5-28]	21 [6-43]
Magadino	108 [79-138]	141 [90-191]	249 [140-358]	9 [3-16]	5 [2-10]	13 [4-29]
Payerne	80 [56-103]	251 [158-344]	331 [183-478]	5 [2-10]	10 [3-21]	16 [4-34]
Chaumont	126 [90-163]	186 [114-258]	312 [169-456]	8 [3-15]	13 [4-28]	21 [6-46]

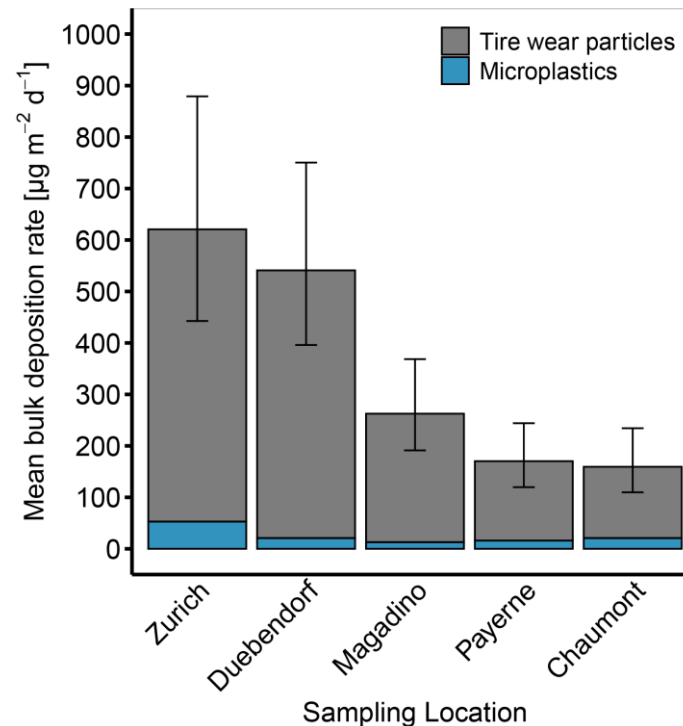
Ashta et al., ACP accepted for preprint



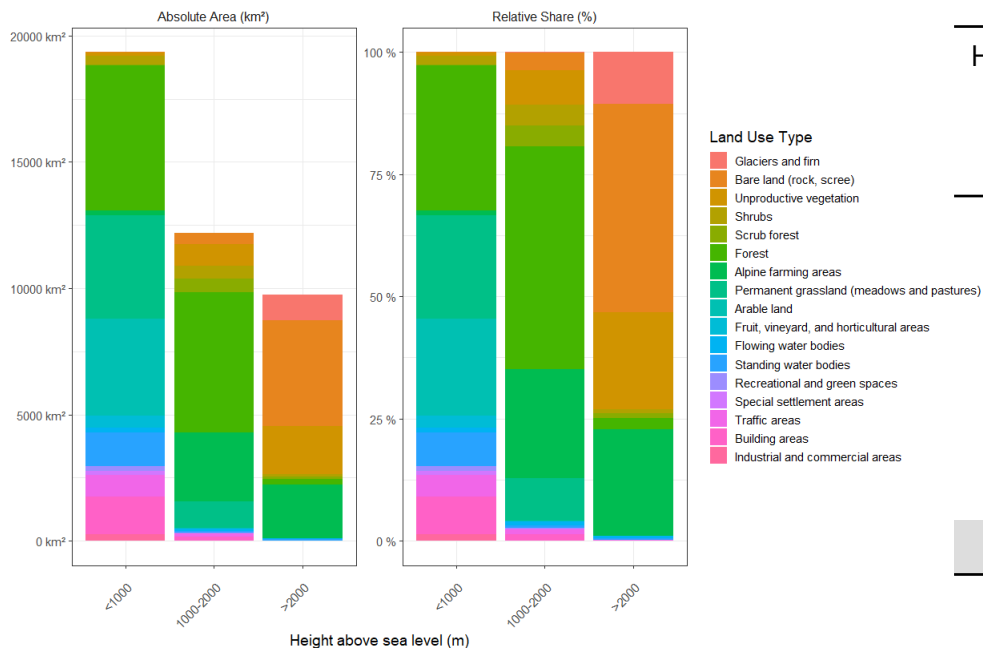
Comparison of atmospheric MP, tire wear particles (TWP) and total dust deposition



	ZUE	DUE	MAG	PAY	CHA
MP : total dust (weight %)	0.12%	0.05%	0.02%	0.03%	0.04%
TWP : total dust (weight %)	1.3%	1.3%	0.3%	0.3%	0.4%



Annual deposition of MP and TWP across Switzerland (<2000 m elevation)



Height Class (m a.s.l.)	Land Use	Area (km ²)	Mass deposition (tons year ⁻¹)	
			MP	TWP
<1000	Non-settlement	16403	87	1209
<1000	Settlement	2944	39	584
1000-2000	Non-settlement	11885	91	601
1000-2000	Settlement	315	2	16
>2000	Non-settlement	9731	n/a	n/a
>2000	Settlement	13	n/a	n/a
Total		41291	219	2410

Source: Bundesamt für Statistik

Conclusions



- **Methods for quantifying MP and tire wear in atmospheric deposition** (Ashta et al., AMT 2026, Rahman et al., in prep.)
- **MP (without tire wear) deposition in Zurich $50 \mu\text{g}/\text{m}^2\cdot\text{day}$, in Duebendorf $\approx$ Magadino $\approx$ Payerne $\approx$ Chaumont $\approx 20 \mu\text{g}/\text{m}^2\cdot\text{day}$**
- **Tire wear particles contribute $10\times$ more than MP to synthetic polymers in atmospheric deposition**
- **$\approx 10'000$ tons of tire wear particles are generated annually on Swiss roads. Estimated $2'410$ tons are transported from the immediate vicinity of roads and enter the environment through atmospheric deposition**

Thank you!

Acknowledgements:

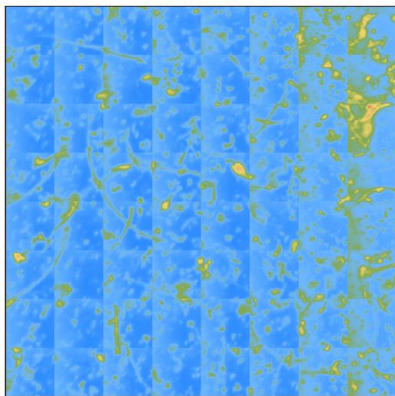
- FOEN and FEDRO for funding (projects Atmo-MP and TRU_20_00E_01 «ATMO»)
- NABEL-Team (FOEN/Empa)



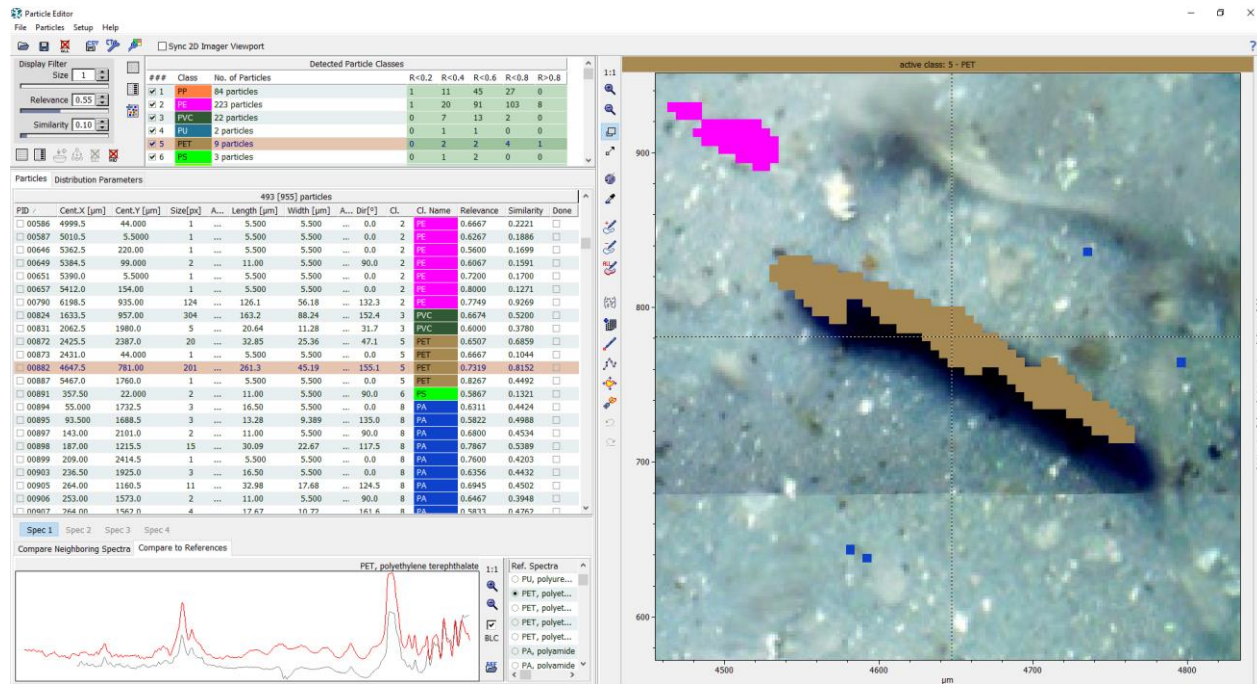
Materials Science and Technology



Analytical workflow → identification of MPs via FPA-μ-FTIR spectroscopy



Automated matching of measured
IR spectra to reference database



Extrapolation of volume/mass of 0–400 μm sized MPs

