THE FOUR SEASONS OF MICRO- AND NANOPLASTIC IN THE AIR

Milena Latz[1], *Elke Ludewig*[2], *Dušan Materić*[1]

[1]*Helmholtz Centre for Environmental Research, Leipzig, Germany*

[2]*GeoSphere Austria, Sonnblick Observatory, Wien, Austria*



Fig. 1: Sonnblick Observatory at 3106m in the Austrian Alps. [1]

INTRODUCTION

- Airborne **Micro- and Nanoplastics** (MNPs) are contaminants of emerging concern
- As environmental pollutants, they remain underrepresented and **poorly investigated**
- Due to their **small size** and **diverse composition**, their detection remains difficult
- Especially **long-term** monitoring studies remain scarce [2,3]

Harmful Effects:

- **Inhalation** as a major exposure pathway increases risks for humans and all mammals [4]
- **Long-range atmospheric transport** to remote areas [5-7]



Fig. 3: Illustration on atmospheric transport of MNPs in a remote alpine region.

Research Aims:

- ➢ Present robust evidence of **current MNPs contamination levels** in the atmosphere
- ➢ Support **evidence-based** decision-making in ongoing policy-dialogues
- ➢ Data will be used for subsequent backward modelling and **Source Apportionment** of MNPs

METHODOLOGY

1) Sampling:

- A PM_{10} **Cascade Impactor** samples airborne **Micro- and Nanoplastics**
- This **active sampling** approach allows for the **weekly** collection of **dry deposition** samples in remote locations
- Particles are fractionated into **four continuous size categories** and collected on quartz filters

2) Analysis via TD-PTR-MS:

- **Qualitative** and **semi-quantitative** analysis of six polymer types: **PE, PP, PS, PVC, PET, TWP**
- A **fingerprinting algorithmn** compares a plastic library to measured sample spectra

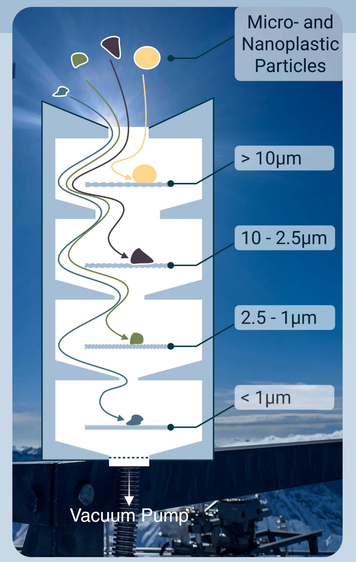
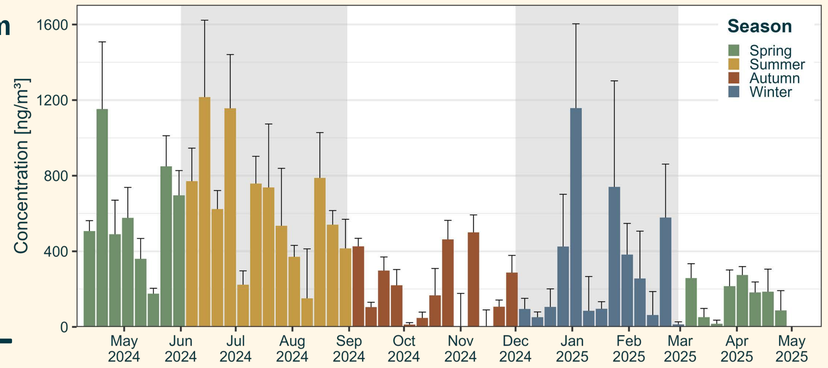


Fig. 2: Schematic setup of a PM_{10} Cascade Impactor. Airborne particles are collected on four continuous filter stages.

RESULTS

- Implementation of a **long-term monitoring study of MNPs** ranging over >52 consecutive weeks
- **Successful detection** of all six polymers, with **PE**, **PET**, **PP** being the most abundant in all fractions (≥30% each)

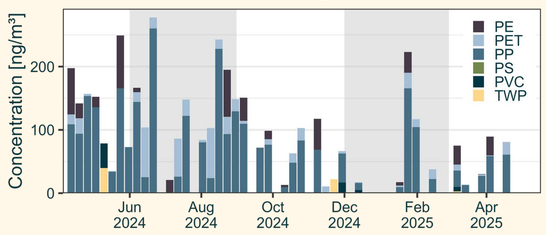
Total Airborne Plastics

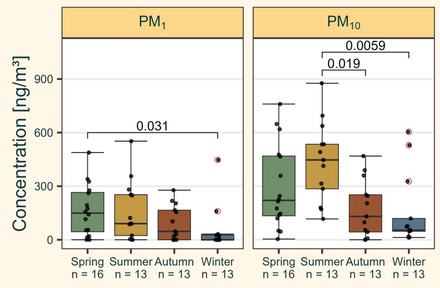


- Detection of significant **seasonal differences**
- Mean total **concentrations** detected throughout the seasons**:**

Summer: 300 ng/m³
Spring: 228 ng/m³
Autumn: 134 ng/m³
Winter: 103 ng/m³

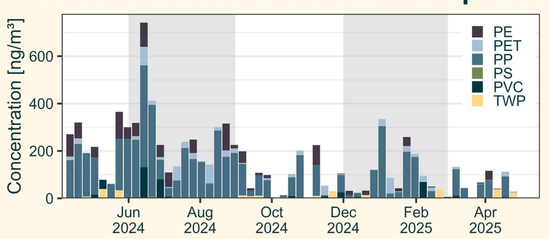
PM_1: Nanoplastics





Pairwise comparisons: Dunn's test; Comparisons show: only significant

PM_{10}: Ultra-fine Micro-and Nanoplastic



TD-PTR-MS – Thermal Desorption–Proton Transfer Reaction–Mass Spectrometry
MNPs – Micro- and Nanoplastics

CONCLUSIONS

PM_1: 31.5% of the total MNPs concentration detected

- Main polymers detected: **PET** (36%), **PP** (31%), **PE** (31%)
- Significant differences: **Spring** - **Winter** (*, p = 0.031)

PM_{10}: 69.4% of the total MNPs concentration detected

- Main polymers detected: **PET** (34%), **PP** (32%), **PE** (30%)
- Significant differences: **Summer** - **Autumn** (*, p = 0.019), **Summer** - **Winter** (**, p = 0.0059)

References:

[1] cc by-nc-sa 4.0, © Hermann Scheer / Sonnblickobservatory / Geosphere Austria
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[4] Rajendran, D. et al. *RSC Adv*. **2023** 13, 31435–31459; 10.1039/D3RA05620A
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Fig2 + Fig3 were created using BioRender.com

Contact:
milena.latz@ufz.de

