Universität Hamburg
DER FORSCHUNG | DER LEHRE | DER BILDUNG

cen

Center for Earth System Research and Sustainability
Department of Earth System Sciences
Institute of Geography

Microplastic particles in atmospheric deposition of Northern Germany – An overview of the methodology of a one year study

Malin Klein[1], Torben Brecht[1], Elke K. Fischer[1]
[1]Centre for Earth Systems and Sustainability, Microplastic Research at CEN (MRC), University of Hamburg

Introduction

Atmospheric microplastic particles play an important role in calculating the input of microplastics in the environment. While a rising number of studies are stating their concern, the extent of input through the atmosphere has been investigated sparsely. Based on a pilot study we presented at the Micro 2018, we started a longtime-study of microplastic particles in the atmosphere of Northern Germany.

The study aims to link microplastic pollution with anthropogenic and meteorological location factors. A new sampling and laboratory protocol was developed, to limit contamination and identify small-scale particles down to 10 µm. Due to Covid-19 restrictions, the laboratory analysis hasn't been completed yet. Therefore, we focus on the methodical approach.

Study Area

The monitoring took place with eleven investigation sites in two different areas of Germany (Fig. 1). The city of Hamburg and the rural area of the Lake Tollense in Mecklenburg-Vorpommern. Three sites were located in the rural south of Hamburg, four sites in urban areas with a focus on heavy population, high traffic or industrial pressure. In Mecklenburg-Vorpommern four investigation sites were positioned north, east, south and west of the Lake Tollense.

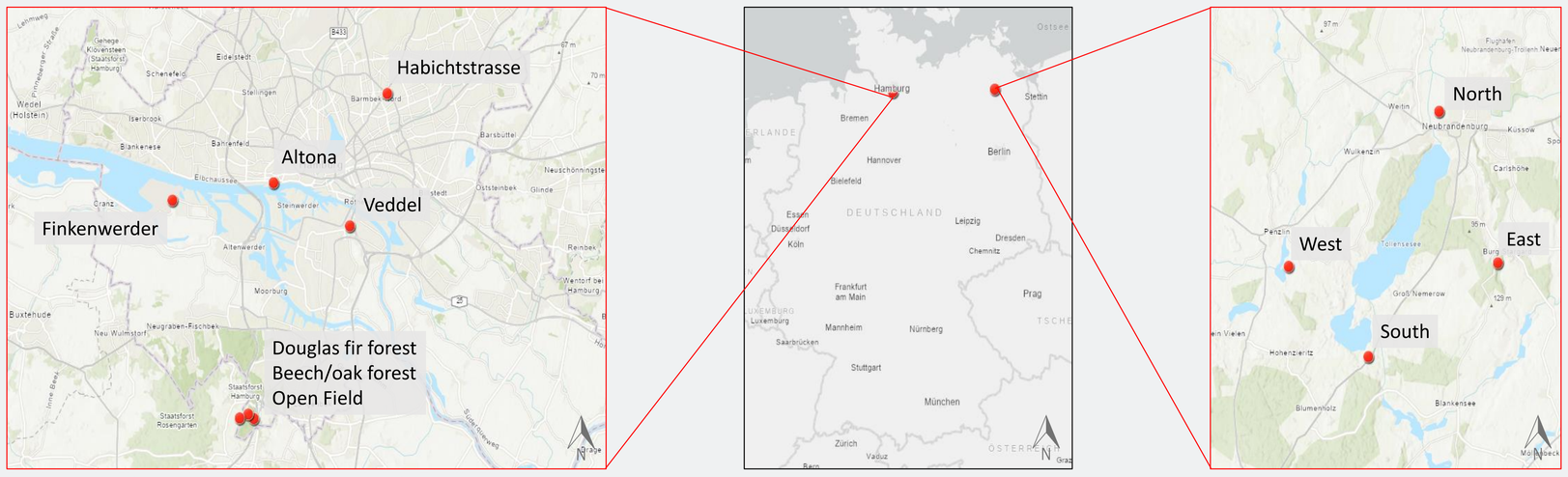

Fig. 1: Maps of the study area. The map on the left shows the sampling sites in Hamburg and the map on the right the ones in Mecklenburg-Vorpommern.

Material & Methods

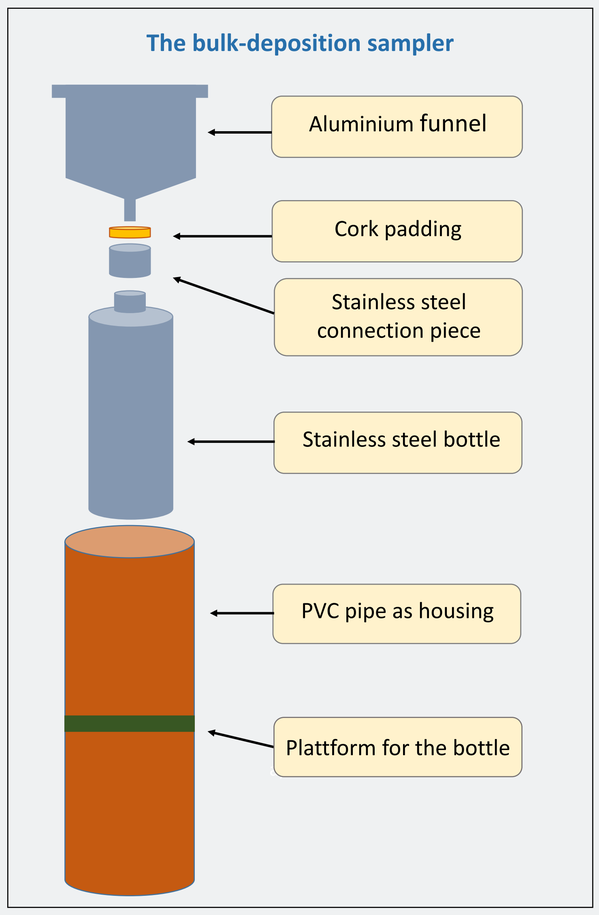

Fig. 2: Sketch of the self build bulk-deposition sampler

To limit the microplastic contamination of the samples, a new bulk-deposition sampler was developed. Unlike regular bulk samplers, all parts that could contaminate the sample are made completely plastic- and rubber-free (Fig. 2). Three of the self build bulk-deposition samplers and one meteorological station were installed at each of the eleven sampling sites. The height was set to 2 m above ground. Sample bottles were changed every four weeks over the course of one year and sealed with a stainless steel cap for transportation. The meteorological data (temperature, humidity, wind speed, wind direction, precipitation) were measured every 15 minutes over the whole sampling period. The volume of the 348 samples plus 12 procedural blanks was determined and then reduced by vacuum filtration onto a PC filter (Whatman 7060-4715). The resulting suspensions were pretreated with hydrogen peroxide (30%) and sodium hypochlorite (7-14 %) in order to destroy biological organic material. The samples were transferred to cellulose filters and underwent staining with nile red solution subsequently. Particles and fibers down to a lower size limit of 10 µm are counted and measured under a fluorescence microscope (Axioscope 7, Zeiss) and verified using µRaman spectroscopy.

Background Contamination

To ensure the quality of the study, twelve procedural blanks were analyzed along the samples. Precautions were taken by using stainless steel equipment and by rinsing all glassware with acetone first followed by MilliQ water. Samples were treated under a dedicated fume hood , surface were wiped down and laboratory coats worn at all times.

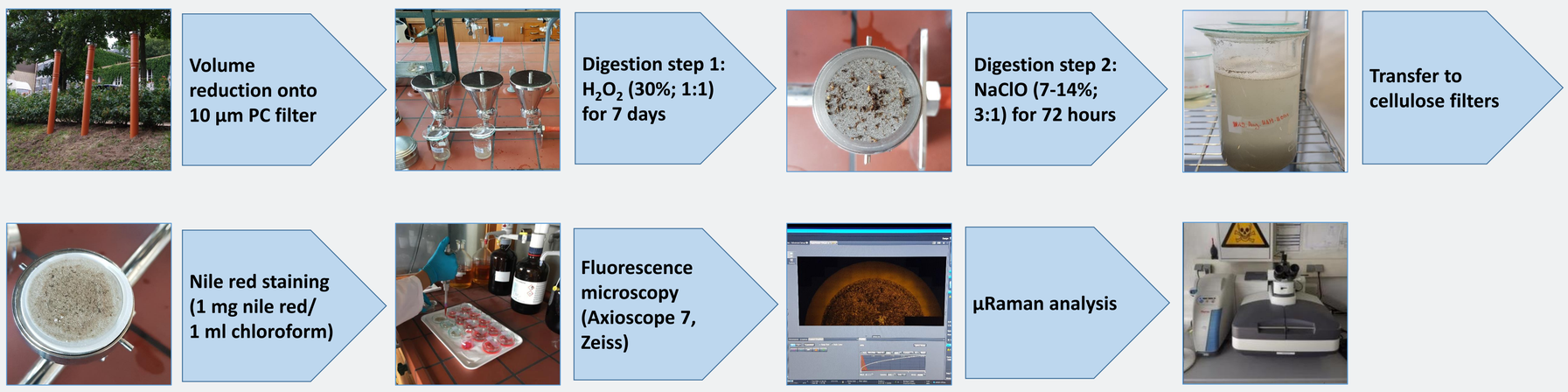

Fig. 3: Flow-chart of the laboratory protocol (simplified)

Preliminary Findings

- The developed bulk-deposit samplers have been working reliable over the whole sampling period and the stainless steel bottles enabled fast and easy sampling.
- Samples are varying in their particle load depending on the sampling location and date. Especially in the summer months the amount of organic and mineral matter was very high and made the digestion steps substantially difficult.
- All samples that have already been investigated under the fluorescence microscope contain microplastic particles. With decreasing particle size, the amount of microplastic particles on the filter increases. The chosen microscope settings and the laboratory protocol allow an identification down to a lower size limit of 10 µm.

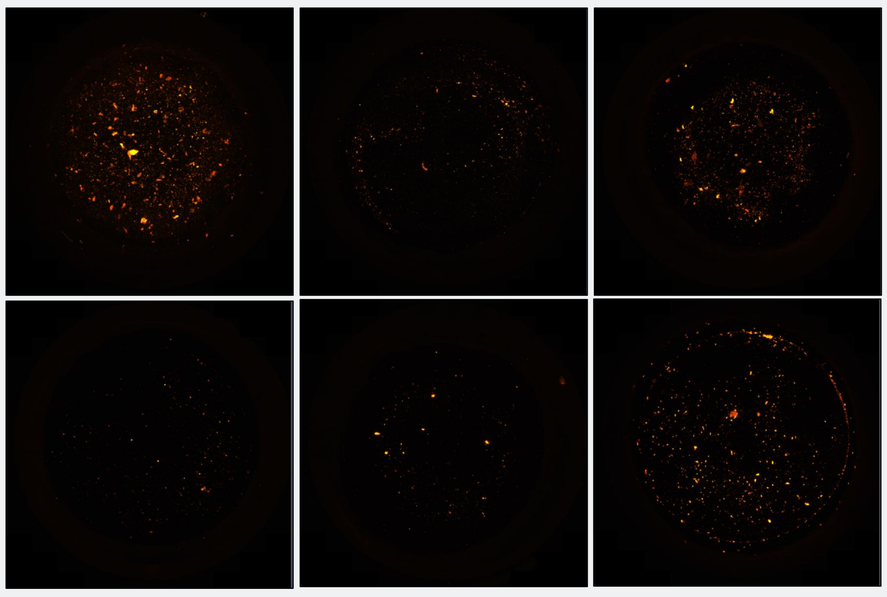

Fig. 4: Images of the filters taken under the fluorescence microscope for March 2020 (from left: Hamburg-Altona, Hamburg-Habichtstrasse, Hamburg-Open Field; Mecklenburg-Vorpommern-East, Mecklenburg-Vorpommern South and Mecklenburg-Vorpommern-West)

Outlook

- Calculation of microplastic concentration per m²/day over a year long sampling period
- Determination of particle size and polymer composition of atmospheric microplastic
- Investigation of differences in microplastic abundance between sampling sites
- Comparison between amount of microplastic and small-scale meteorological data

Cooperation Partners

We thank the Luftmessnetz Hamburg and the Neubrandenburger Stadtwerke for granting access to the sampling locations.

Contact: Malin Klein, CEN, University of Hamburg, malin.klein@uni-hamburg.de