Detection of Atmospheric Microplastic Fallout in the Southwestern Appalachian Mountain Region in the United States

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Background

Larger plastic fragments break down into miniscule plastic fragments called microplastics, which are typically less than 5 mm in size. Due to their small size and density, microplastics have been recently detected in urban, suburban, and even remote areas, suggesting the potential for long-distance atmospheric transport.

In this study, we investigate atmospheric microplastic deposition in Blacksburg, Virginia. These preliminary study findings will serve as the foundation for a long-term sampling effort in the Appalachian Mountain region in Southwest Virginia, USA.

Figure 1. Microplastics are miniscule in size.[1]

Visual Identification

- **ImageJ** was used to survey > 50% of the sample filter's area & identify and initially count the number of potential microplastics.
  - Selected 56 potential microplastics.
- Visual identification of atmospheric microplastic are based on the following **guidelines**[4]:
  - Cellular structure: No biogenic (organic or cellular) structures.
  - Size: Fibers have relatively consistent thickness.
  - Color: Homogeneous coloring with a level of transparency.

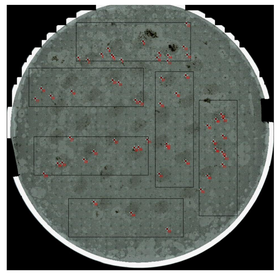


Figure 4. Annotated sample filter.

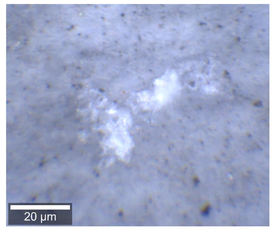
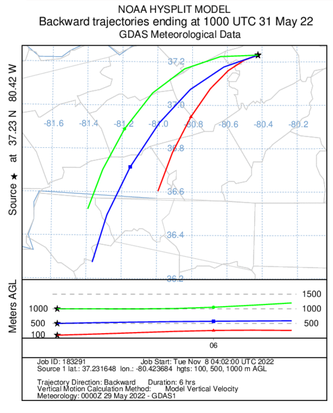


Figure 5. White PE film at 20x magnification.

Results

- **A polyethylene (PE) film particle was identified using guidelines and Raman spectroscopy.**
- **Observed particles of different sizes and shapes (i.e. fibers).**

HYSPLIT Analysis



The Hybrid Single-Particle Lagrangian Integrated Trajectory model (HYSPLIT) is a computer modeling program that was used to identify the origin and distance of microplastic transport.

Parameters:

- Resolution: 1 degree using the Global Data Assimilation System (GDAS)
- Run time: 6 hours with a settling velocity of 3.5 centimeters per second
- Height: 100-1000m above ground level

Using a 6-hour backward trajectory path, microplastics may be deposited from over 57 miles away from as far as Wilkes County, NC, USA.

Collection Methodology & Organic Matter Removal

Sample Collection

Implemented pilot study to collect and identify airborne microplastics in Blacksburg, VA from May 19 – May 31, 2022 (13-day period).

- Virginia Tech campus suburban area is exposed to rainfall and wind.
- Stainless steel beaker passive sampler.[2]
  - Durable against weather conditions
  - Easy to extract sample and less transfer error

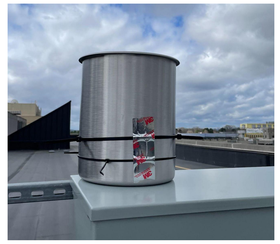


Figure 2. Passive sampler securely mounted on Durham Hall roof on campus.

Filtration/Organic Matter Removal

- Vacuum filtered samples using 47 mm polycarbonate (PC) filter, ethanol (96%), and borosilicate glass filtration equipment.
- Hydrogen peroxide (30%) digested organic matter.[3]
- Sample kept in oven at 55°C for 7 days.

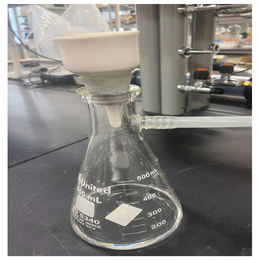


Figure 3. Filtration procedure of the samples post collection.

Raman Spectroscopy Analysis

- **The Raman spectroscopy** was used on potential microplastics to determine whether they were in fact microplastics.
- Spectra were processed using Spectragryph[5] software to compare to a microplastic database (tested using a known HDPE sample, i.e., shampoo bottle).

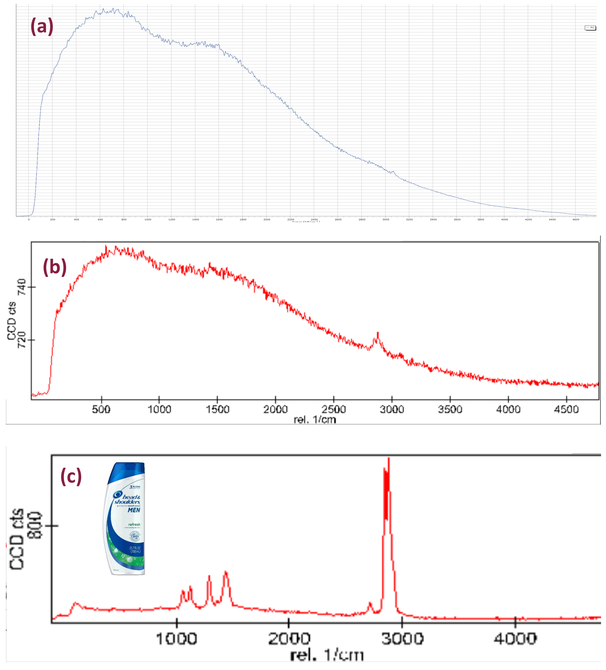


Figure 6. Comparison between relevant PE spectra.

(a) Polycarbonate filter background spectra.

(b) PE film spectra including polycarbonate filter background, distinct peak near 2900 cm^{-1}.

(c) Known HDPE spectra example.

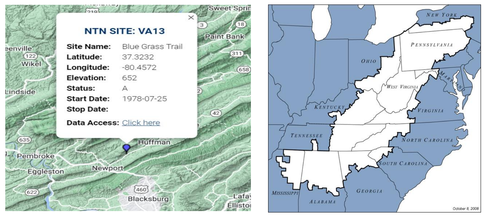
One film was found that had a weak but significant Raman peak for polyethylene.

Conclusions

- A single polyethylene film was identified on the sample filter using Raman spectroscopy, suggesting the presence of atmospherically deposited microplastics on campus.
- Seven-day organic matter digestion process at selected temperature is sufficient in removing organic debris.
- Field sampling can be carried out now that the methodology is successful in identifying microplastics.

Future Work

- Place passive sampler at a local National Atmospheric Deposition Program (NADP) site.
- Add more passive sampler locations across the Appalachian Mountain region.



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5. https://www.effemm2.de/spectragryph/

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