Abundance of tire tread wear particles in West Siberian snow cover

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INTRODUCTION

- One of the current problems of mankind is the pollution of the environment with microplastics (MPs). Studies of MPs in the atmosphere began not so long ago, but it has already been revealed a global transport of MPs in the atmosphere (**Table 1**).
- The main danger of MP airborne transport is associated with the possibility of the entering the human body by inhalation. Together with POPs, heavy metals and other toxic substances MPs can enter the lungs and cause adverse physiological effects in the body.
- It is possible to determine MP content in the atmosphere due to dry and wet deposition (i.e. rain, snow precipitation). This method allowed to reveal that the predominant type of MPs in the atmosphere are particles of tire tread wear (TWPs) and road wear particles (RWPs).
- **The purpose of the study** is to determine the amount of tire particles in atmospheric precipitation in West Siberia.

Table 1. World MP concentrations in the atmosphere

Location	Sample type / Identification method	Average MP deposition, items m^{-2} per day	Reference
London, UK	Fallout / visual, FT-IR	575 - 1008	Wright et al., 2020
Yantai, China	Fallout	602	Zhou et al., 2017
Pyrenees, France	Fallout / visual, Raman	365	Allen et al., 2019
Dongguan city, China	Fallout	172 - 313	Cai et al., 2019
Protected areas, USA	Dry and wet deposition / visual, FT-IR	132	Brahney et al., 2020
Paris, France	Fallout / visual	118	Dris et al., 2015

METHODS

- Snow core samples from 25 sites scattered from the Altai Mountains to the Arctic Circle (**Fig. 1)** were collected in late February – early March, 2021 to access total deposition of TWPs for the whole winter (about 120 days).
- The distance to the nearest road varied from 50 to 800 m. Road surface was predominantly asphalt.

Fig. 1. Map of the sampling locations (QGIS 3.18.3) (a), conducting snow core sampling (b) and packaged samples (c).

- Three samples were taken per site from the square of 78.5 cm^2 each.
- Organic material was digested using wet peroxide oxidation. Particles were separated in a 1.20 g mL^{-1} NaCl solution and collected by vacuum filtration on the 0.45 μm acetate cellulose filters.
- Contamination during the sampling and processing was controlled using replicated procedural blanks of negative controls with filtered water.
- TWPs and total MPs was counted by visual microscopy and verified using inVia™ confocal Raman microscope (Renishaw, UK).

RESULTS

- TWPs up to 118 μm (**Fig. 2**) were detected in snow samples from the most of sites. However, particle concentrations varied widely among different sites with the maximum of 192 items L^{-1} melted snow or 13,439 items m^{-2} in relatively populated area in the South-West of the region (Omsk city, 1.16 million population).

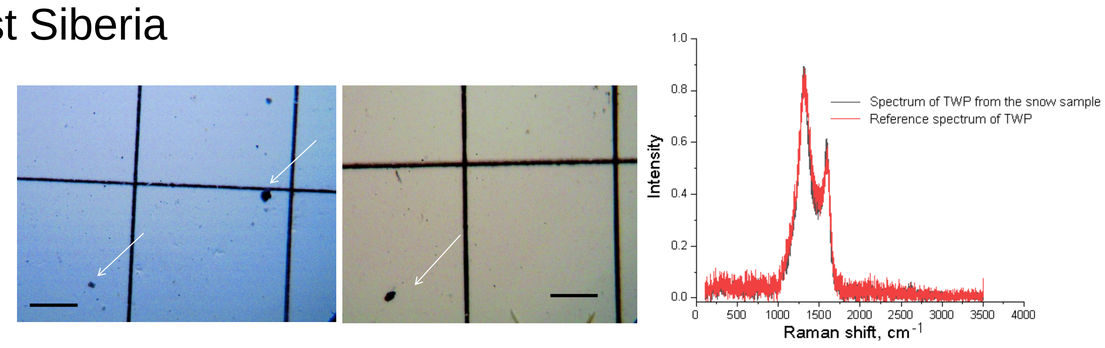

Fig. 2. Microphotographs and Raman spectrum of TWPs from West Siberian snow. Scale bar is 1 mm

- TWP concentration in snow samples collected near the largest city, Novosibirsk (1.51 million population) was only 9 items L^{-1} melted snow. This is significantly lower compared to smaller some settlements – Tobolsk (100,000 population; 44 items L^{-1}), Barabinsk (28,500; 23 items L^{-1}), Kogalym (61,000; 10 items L^{-1}).
- The average deposition of MPs in Novosibirsk (2,038 items m^{-2} that corresponds to ~17.0 items m^{-2} per day) were also lower than those in the snow samples collected in less populated urban areas like Omsk (~112 items), Tobolsk (~35.0 items) and Barabinsk (~17.5 items m^{-2} per day) (**Fig. 3**).
- Distance of sampling sites from roads did not significantly affect TWPs deposition (data not shown).
- The ratio of TWPs to the total concentration of MPs indicates that tire tread abrasion contributes up to ~95 % load of the total concentration of particles in snow samples near large cities (**Fig. 3)**.

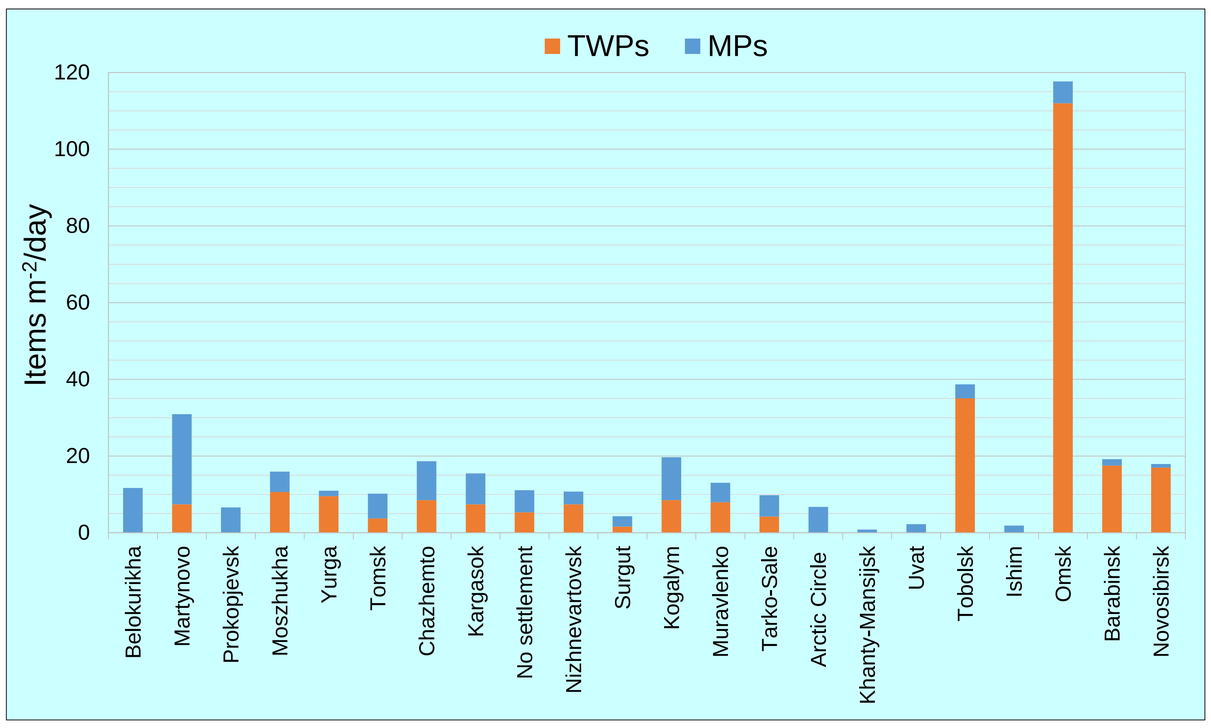

Fig. 3. The average TWP deposition relatively to the average MPs, items

CONCLUSIONS

- TWP concentrations in Siberian snow were not directly associated with population density and distance from roads, obviously depending on natural and climatic factors.
- TWPs is the predominant type of MPs in atmospheric precipitation near large cities.
- Further studies are required for better understanding the MP transport and fate in the atmosphere.

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