1. Motivation and research questions

Laboratory studies have demonstrated that microplastics (MPs) can act as ice nuclei in the immersion freezing mode (Seifried et al., 2024; Busse et al., 2024). Moreover, MPs have been detected in cloud water at altitudes up to 3500 m asl (Wang et al., 2023), suggesting a potential influence on cloud formation and properties. But to which extent?

Our goal is to assess the contribution of MPs to ice nuclei concentration on a global scale. As a case study we use of road traffic-related microplastics (tire wear particles (TWPs), brake wear particles (BWPs), road marking particles (RMPs), and polymer modified bitumen plastics (PMBPs)), since this type of emissions is considered the best understood and likely is the largest primary source of MPs.

So, our research questions are:

1. What is the number concentration of road traffic-related MP particles in the atmosphere? 2. To what extent do road traffic-related MP particles contribute to the total INP concentration in mixed-phase and cirrus clouds?



 $fr = 0.0159 \cdot T^2 + 0.6284 \cdot T + 6.2157$





Department of Meteorology and Geophysics

Do Microplastics Contribute to the **Total Number Concentration of Ice Nucleating Particles?**

Abstract is here

Full paper is here

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THE ANSWER IS **YES**! In some regions, the concentrations of MPs may be sufficient to induce heterogeneous nucleation of ice crystals.

IN MIXED-PHASE CLOUDS at -38° < T < -18°C



Comparison with modeled estimates by Beer et al., 2022 (*mineral dust*)



Contribution of MPs [%]

0.00001	0.0001	0.001	0.01
0.0001	0.001	0.01	0.1
0.001	0.01	0.1	1.0

MIN 259 ± 9 kt/year

fr = 0.1, 0.01, 0.001

Comparison with modeled estimates by Herbert et al., 2024 (*mineral dust + marine-based aerosols*)

IN CIRRUS CLOUDS

0 1	1	<i>fr</i> :0.001
1.0	 10	<i>fr</i> :0.01
10	100	<i>fr</i> :0.1

4. Results



- Ο highest road traffic density.
- Arctic, and upper tropical troposphere.
- phase clouds.
- Antarctic in MAX (MIN) scenario.

5. Key conclusions

MPs are dispersed throughout the troposphere and can reach regions with low concentrations of natural ice nucleating particles.

In such regions, the local contribution of MPs can be sufficient enough to trigger heterogeneous nucleation of ice crystals in mixed-phase or cirrus cloud.

Thus, MPs may be able to affect cloud formation in some regions!

Hence, they may indirectly affect atmospheric and climate processes.

6. References

Seifried et al. Environmental Science & Technology, 58 (35) (2024) Busse et al. Environmental Science & Technology Air, 1(12) (2024) Wang et al. Environmental Chemistry Letters, 21 (6) (2023) Evangeliou et al. Nature Communications, **11** (3381) (**2020**) Kreider et al. Science of the Total Environment, 408 (3) (2010) Broeke et al. Emission estimates for diffuse sources, Netherlands emission inventory (Tech. Rep.) (2008) Snilsberg et al. Road Materials and Pavement Design, 9 (1) (2008)

The highest concentrations are associated with the

• MPs reach regions with low natural INPs (mineral dust or bioaerosols) such as over the Southern Ocean and the

• MPs account for up to about 40% (20%) of all ice nuclei in some regions in tropics in MAX (MIN) scenario in mixed-

 \circ MPs account for up to 7% (3%) of all ice nuclei in some regions in tropical Pacific and up to 20% (7%) over East