Atmospheric microplastics modelling and quantification using Gibbs sampler

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Atmospheric microplastics budget is estimated and associated uncertainties are quantified. We use microplastics measurement data from remote areas and national parks in the United States (Brahney et al., 2020) to estimate atmospheric microplastics budget. Since the number of unknowns in spatial-temporal domain (Eastern US) is much larger than the number of measurements, we regularize the space of possible solutions using spatial-temporal patterns from previously reported sources, namely mineral dust, road dust, agriculture, sea spray and ocean surface. In inversion scheme, we optimize measurements and patterns footprints linked to these measurements with the use of calculated source-receptor-sensitivities from the atmospheric transport model FLEXPART 11.

the Lagrangian particle dispersion model FLEXPART version 11 (Bakels et al. 2024) was driven with ERA5 assimilated meteorological analyses (Hersbach et al. 2020) (137 vertical levels, hourly temporal resolution and 0.5° x 0.5° spatial). is suitable to model MPs considering shape corrections during gravitational settling of shapes other than spheres (Tatsii et al. 2024).

The optimization procedure of measurements and patterns footprints is based on Gibbs sampling method. We construct a hierarchical Bayesian model whose parameters are optimized using Gibbs sampler. Hence, we obtain estimated microplastics emissions in the form of samples from posterior distributions, quantifying effectively uncertainties of estimated mean and median values.

In the order of magnitude with previous estimates in literature (Brahney et al., 2021, Evangeliou et al., 2022), the total estimated emissions are 1336 Gg/y, see Figure 1, while the associated uncertainty is almost on the same level as emissions. The most significant sources of atmospheric microplastics are ocean sources and road micrplastics (tire and brake wear).

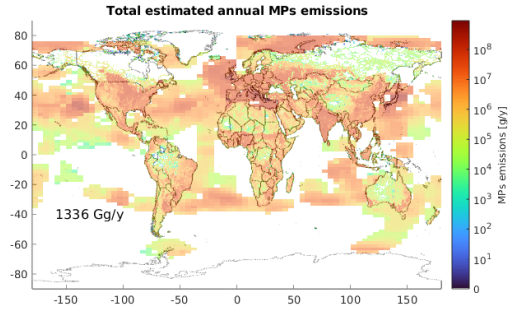

Figure 1. Spatial distribution of estimated yearly microplastics, together with total annual budget.

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