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Atmospheric microplastics emissions estimation and uncertainty quantification using Gibbs sampler

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This study quantifies microplastics based on atmospheric concentration measurements, achieved by optimizing the measurements against the theoretical output of an atmospheric transport model. The core of our contribution is addressing the severe ill-posedness of this inverse problem, as the solution space for spatial-temporal emissions is much larger than the number of available measurements. For regularization of the inverse problem, we assume that microplastics sources follow patterns from agriculture, dust, road dust, and ocean emissions. The emissions are mapped to measurements using source-receptor sensitivity relations, forming an optimization problem. To rigorously estimate emissions and precisely quantify the associated uncertainties, we developed a hierarchical prior model, whose parameters are estimated using a Gibbs sampler. Our results show that the estimates are significantly uncertain, with standard deviations often being about the same size as the mean values. We conclude that uncertainties are reasonably quantified considering the issue related to the microplastics measurements and modeling.

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