EGU21-16473
https://doi.org/10.5194/egusphere-egu21-16473
EGU General Assembly 2021

Constraining the atmospheric limb of the plastic cycle

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Plastic pollution is one of the most pressing environmental and social issues of the 21st century. Recent work has highlighted the atmosphere's role in transporting microplastics to remote locations. Here we use in situ observations of microplastic deposition combined with an atmospheric transport model and optimal estimation techniques to test hypotheses of the most likely sources of atmospheric plastic. Results suggest that atmospheric microplastics in the western USA are primarily derived from secondary re-emission sources including roads, the ocean and agricultural soil dust. Using our best estimate of plastic sources and modeled transport pathways, most continents were net importers of plastics from the marine environment, underscoring the cumulative role of legacy pollution in the atmospheric burden of plastic. This effort is the first to use high resolution spatial and temporal deposition data along with several hypothesized emission sources to constrain atmospheric plastic. Akin to global biogeochemical cycles, plastics now spiral around the globe with distinct atmospheric, oceanic, cryospheric, and terrestrial lifetimes. Though advancements have been made in the manufacture of biodegradable polymers, our data suggest that extant non-biodegradable polymers will continue to cycle through the Earth's systems. Due to limited observations and understanding of the source processes, there remain large uncertainties in the, transport, deposition, and source attribution of microplastics. Thus, we prioritize future research directions for understanding the plastic cycle.