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Evaluation of Delft3d Microplastic Model of the Mid-Atlantic New Jersey Coast Using Summer and Winter Field Measurements

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As microplastics are being discovered on every corner of the earth, it is imperative to understand how they get there. Modeling capabilities of both the hydrodynamic processes and particle behavior are improving, but it remains expensive to collect and identify microplastics in coastal settings. This highlights the need for and potential of accurate marine debris models. This project compares microplastic deposition field measurements and model predictions on the New Jersey, USA coastline. The objective is to better understand the primary hydrodynamic forcing mechanisms of marine debris. Here, we test the hypothesis that the ability of the model to capture the longshore distribution of microplastic deposition is sensitive to hydrodynamic conditions, particle density, source location(s), and beaching and resuspension rates.

We created a regional hydrodynamic model in Delft3D of the New Jersey coastline from back bay river mouths to 50km offshore, using tidal, wind, wave, and river discharge conditions from 2016. We ran the model from January 1st, 2016 until December 31st 2016 to capture the seasonality of the flow and wind conditions. We used the Delft3D particle tracking module to insert particles with properties (e.g. particle density, horizontal diffusivity, and beaching probability) defined to best represent the behavior of microplastic particles and monitor their transport and fate. To assess the ability of a regional hydrodynamic model paired with a particle tracking module, 28 beaches were selected from the New Jersey coastline and sampled for microplastics (1-5mm) using methods similar to the US Environmental Protection Agency's Microplastic Beach Protocol that detail consistent and characteristic microplastic measurement techniques of sandy beaches. The same sites were measured once in the winter of 2020/2021 and again in summer 2021 in an effort to capture the different seasonal flow regimes of the Mid-Atlantic coast.

Here, we show the comparison between the predicted microplastic deposition on the New Jersey coastline to the measured microplastic distribution for both the summer and winter. We assess the ability of the model to predict transport and deposition of various types and densities of microplastic debris. We illustrate the power that particle tracking models have to capture the transport and fate of microplastic debris and highlight the limitations of such models that need to be addressed. Further, we discuss the importance of predictive microplastic models for targeting specific geographical regions for cleanup and mitigation efforts.