Developing a 3D Trajectory Modeling System to Predict Ocean Floor Microplastic Aggregation Using a Voxel-Based Neural Network Approach

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Abstract The improper disposal of plastic waste has led to an abundance of plastics in the oceans, introducing a wide range of toxins along with a potential global health crisis. However, the field of microplastic pollution prediction via data-modeling systems is still in early stages, with no comprehensive, high resolution, three dimensional trajectory modeling systems that clearly show patterns of plastic pollution distribution from the surface of the ocean to the ocean floor. This system was developed to simulate 3D trajectories of individual plastic particles using a Lagrangian model, which utilizes recurrent neural networks trained with data from various prominent factors within specific regimes of ocean depths obtained from a number of different sources. Gravitational descent rate was calculated at each vertical depth layer based on matrices determining the effect of various factors on particle downward trajectories, which were informed by a sensitivity analysis. This allowed the optional entry of a custom range of input values with presets determined by weighted medians of publicly and experimentally sourced data. Recurrent neural networks were used to post-process model output data for later use in spatial-mapping predictions. Particle density distribution maps were generated, highlighting regions of plastics aggregation, predominantly near gyres. After verifying the model using comparisons to peer-reviewed publications of surface microplastic mapping data, it was determined that this novel technique demonstrates a >90% probability of accurately predicting ocean-floor accumulation zones, with a p-value of 10-5. This system lays the groundwork for future studies regarding accurate ocean floor microplastic aggregation hot-spot zone prediction.

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