Readme

1. Introduction

Welcome to the simulation models for low-density microplastic settings in the open oceans. The model is combined with several programs (.ipynb) explicitly processed on Jupyter Notebook. Users are encouraged to perform a reproduction of the simulation in the manuscript or use their dataset for further exploration. The simulation model can generate low-density microplastics with different characteristics, estimating their trajectories under various oceanic conditions and seasons. Due to the extreme size of the database, the current program only provides two sets of global ocean physical and chemical data for simulation and reproduction under typical seasons (summer and winter). If users need inter-annual ocean physical and chemical data daily, please get in touch with us to provide more detailed datasets.

2. System requirements

2.1. Software dependencies and operating systems

2.1.1. Software dependencies

This model is programed using Python 3.7 and running in Jupyter Notebook powered by Anaconda. The supporting database includes numpy, pandas, matplotlib, netCDF4, Basemap. Please make sure that these databases have been installed in your Jupyter Notebook.

2.1.2. Operating systems

All the operating systems, including Windows, Mac OS, and Linux, which could run

Anaconda normally can be used to process the present model.

2.2. Versions the software has been tested on

Windows 10 Education

Anaconda 4.6.11

Python 3.7.3

numpy 1.21.6

matplotlib 3.5.0

pandas 1.3.5

netCDF4 1.5.8

Basemap 1.2.2

3. Installation guide

3.1. Instructions

1. Download the zip file

2. Extract the file and place the folder under Jupyter Notebook working folder

(Typically under Windows user -- username folder)

3. Open Jupyter Notebook and the model folder should be seen in the Jupyter

Notebook file interface.

3.2. Typical install time on a "normal" desktop computer

Approximately 30 minutes.

4. Demo

4.1. Instructions to run on data

There are 9 programs (.ipynb) in the folder. All necessary datasets for modeling

are stored in the Data folder. The outputs will be saved in the Output folder. To run the model and generate Figure 1-6 in the manuscript, a specific order is given as follows:

1. Fig. 1: Open Fig_1.ipynb, press the run icon.

2. Fig. 2: Open Fig_2.ipynb, press the run icon.

3. Fig. 3: Open Random_LDMP_Generator.ipynb, press the run icon;

   Open the Monte_Carlo_LDMP_Traj_Fig_3.ipynb, press the run icon;

   Open the Fig_3.ipynb, press the run icon.

4. Fig. 4: Open Fig_4.ipynb, press the run icon.

5. Fig. 5: Open Fig_5A.ipynb, press the run icon;

   Open Fig_5.ipynb, press the run icon;

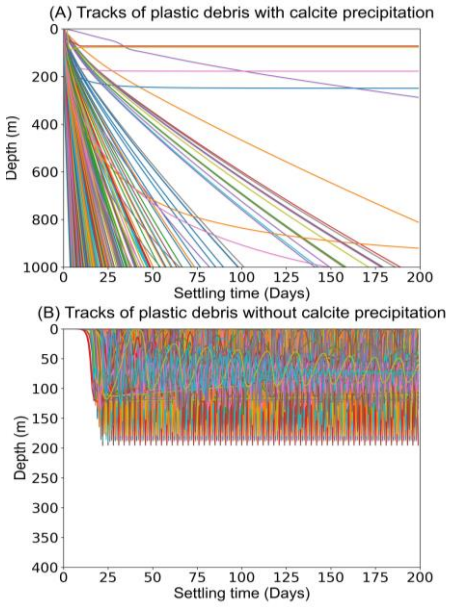
6. Fig. 6: Open Random_LDMP_Generator.ipynb, press the run icon;

   Open the Monte_Carlo_LDMP_Traj.ipynb, press the run icon;

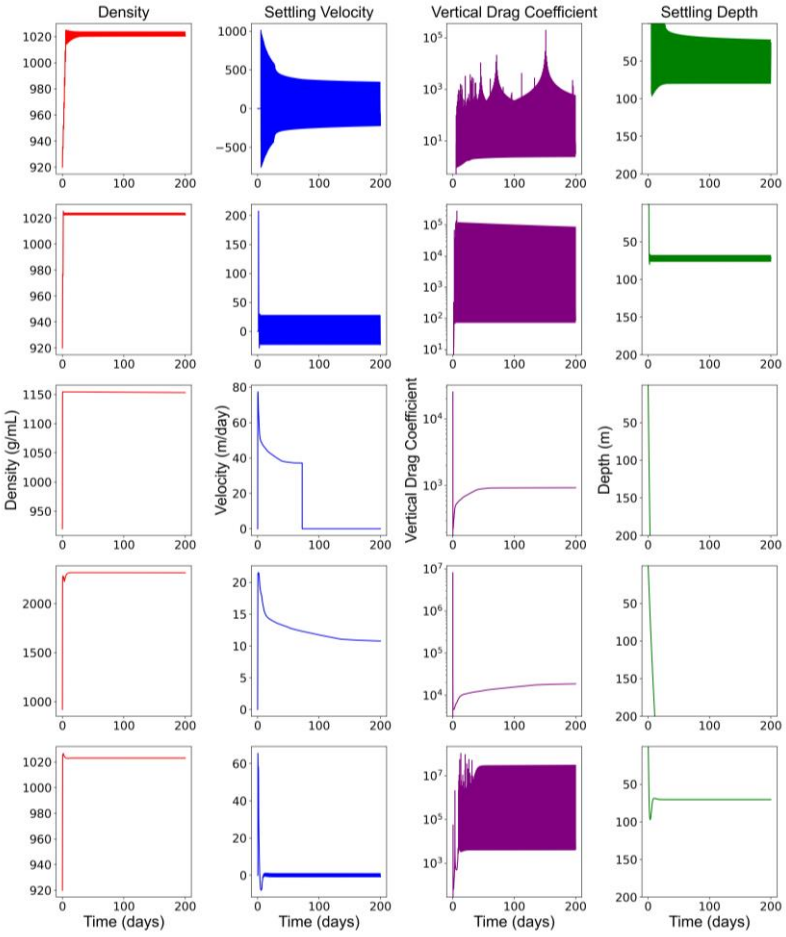
   Open the Fig_6.ipynb, press the run icon.

4.2. Expected output

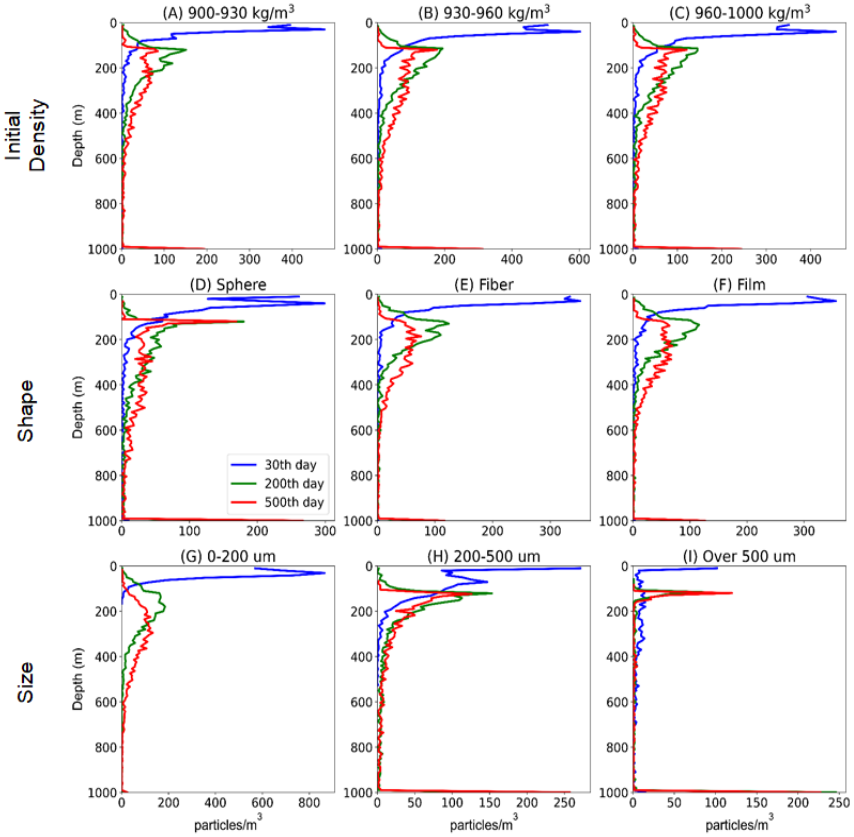
1. Fig. 1:



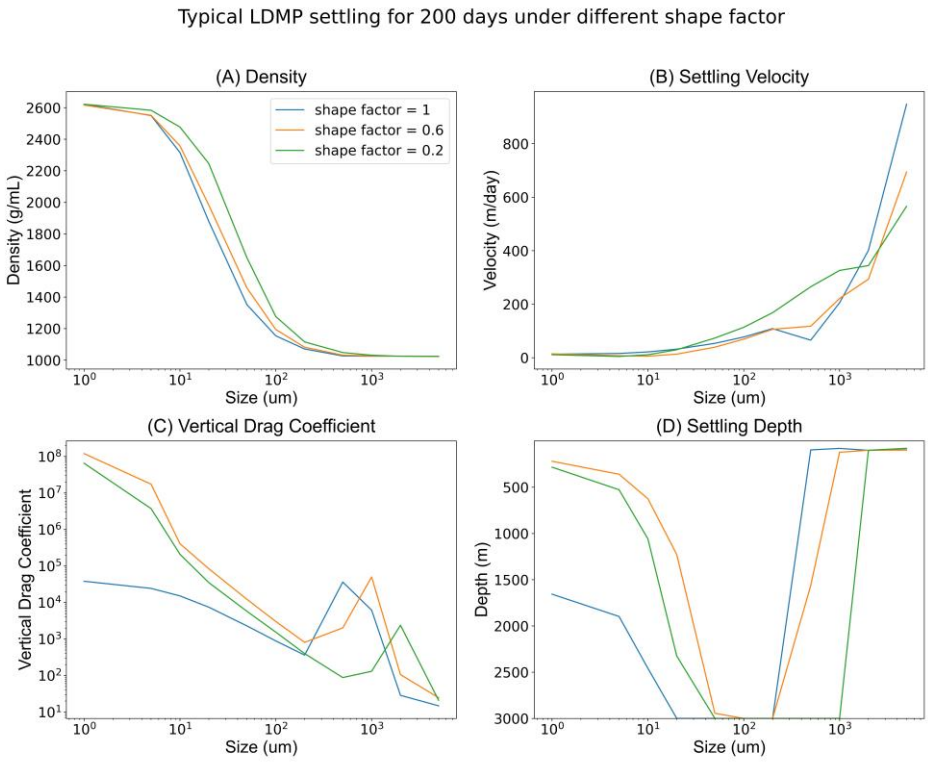
2. Fig. 2:



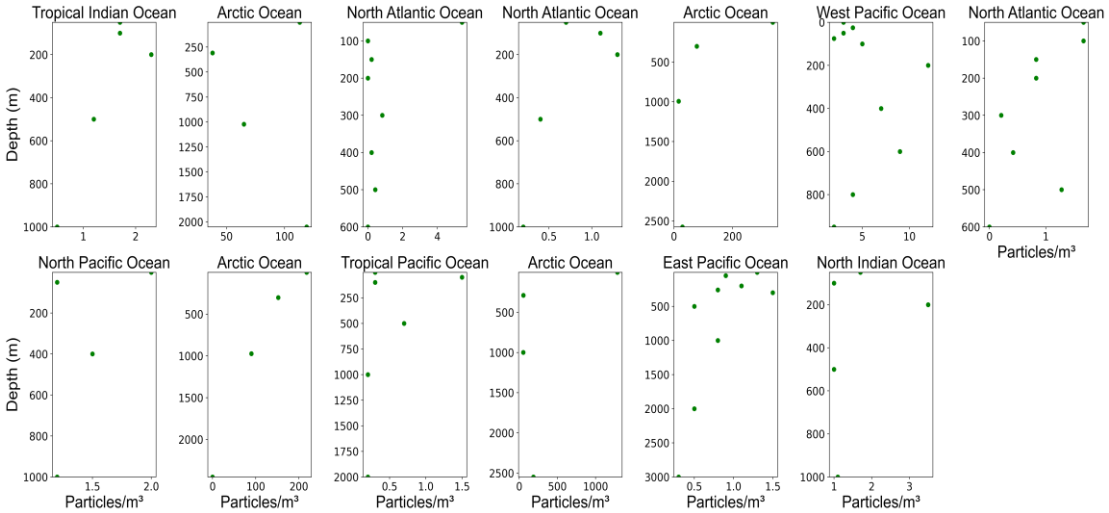
3. Fig. 3:

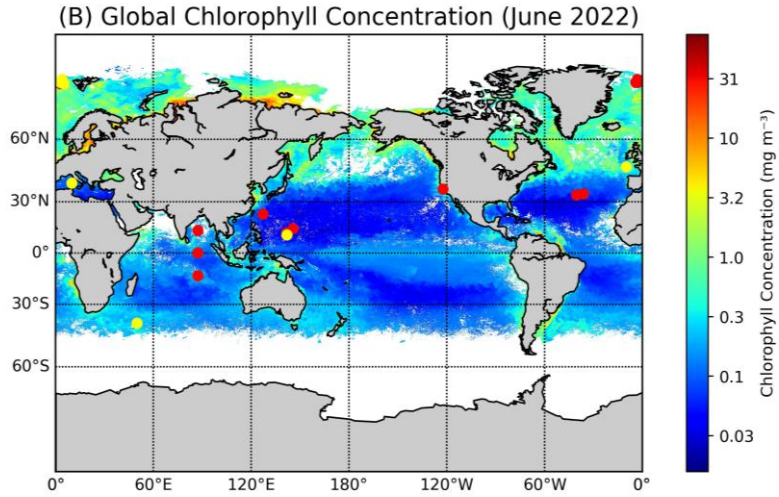

(A) 900-930 kg/m3
(B) 930-960 kg/m3
(C) 960-1000 kg/m3
Initial Density
(D) Sphere
(E) Fiber
(F) Film
Shape
30th day
200th day
500th day
(G) 0-200 um
(H) 200-500 um
(I) Over 500 um
Size
Depth (m)
particles/m3

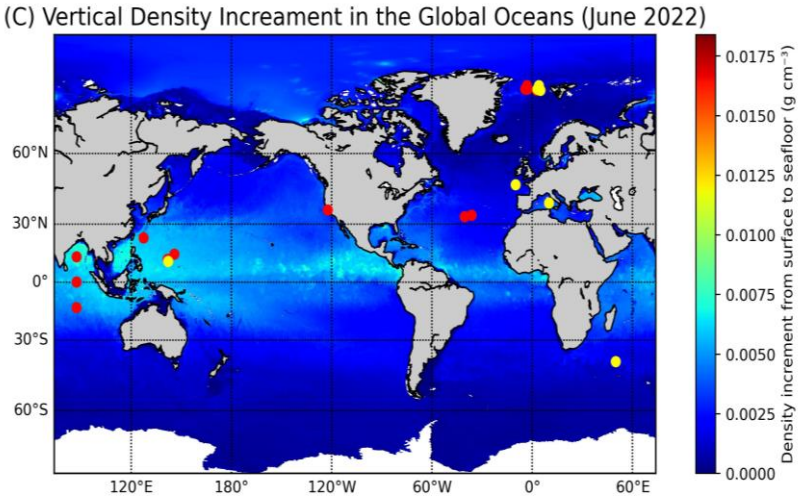
4. Fig. 4:


Typical LDMP settling for 200 days under different shape factor
(A) Density
shape factor = 1
shape factor = 0.6
shape factor = 0.2
Density (g/mL)
(B) Settling Velocity
Velocity (m/day)
(C) Vertical Drag Coefficient
Vertical Drag Coefficient
(D) Settling Depth
Depth (m)
Size (um)

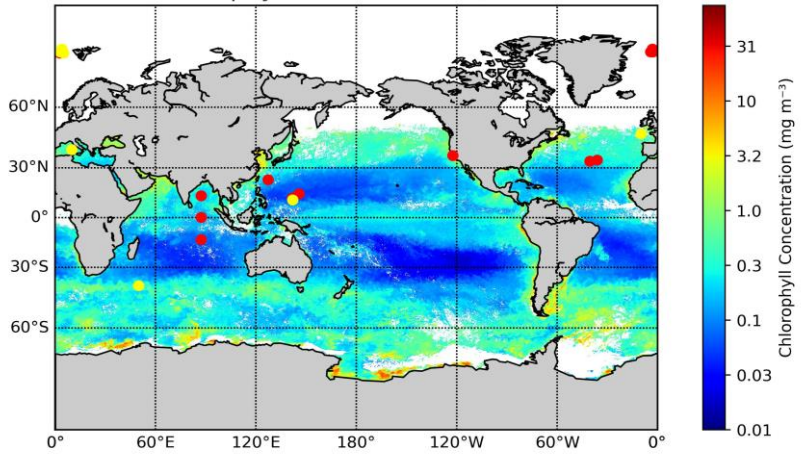
5. Fig. 5:


Tropical Indian Ocean
Arctic Ocean
North Atlantic Ocean
North Atlantic Ocean
Arctic Ocean
West Pacific Ocean
North Atlantic Ocean
North Pacific Ocean
Arctic Ocean
Tropical Pacific Ocean
Arctic Ocean
East Pacific Ocean
North Indian Ocean
Depth (m)
Particles/m³

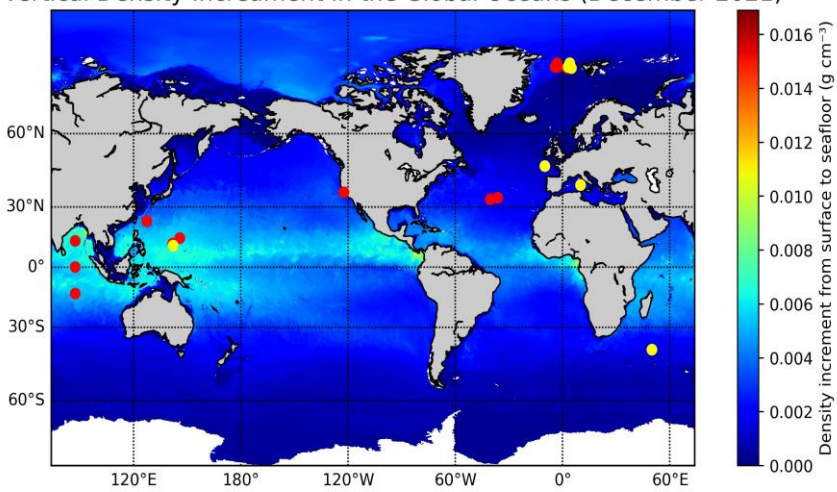

(B) Global Chlorophyll Concentration (June 2022)
60°N
30°N
0°
30°S
60°S
0°
60°E
120°E
180°
120°W
60°W
0°
31
10
3.2
1.0
0.3
0.1
0.03
Chlorophyll Concentration (mg m⁻³)


(C) Vertical Density Increament in the Global Oceans (June 2022)
60°N
30°N
0°
30°S
60°S
120°E
180°
120°W
60°W
0°
60°E
0.0175
0.0150
0.0125
0.0100
0.0075
0.0050
0.0025
0.0000
Density increment from surface to seafloor (g cm⁻³)

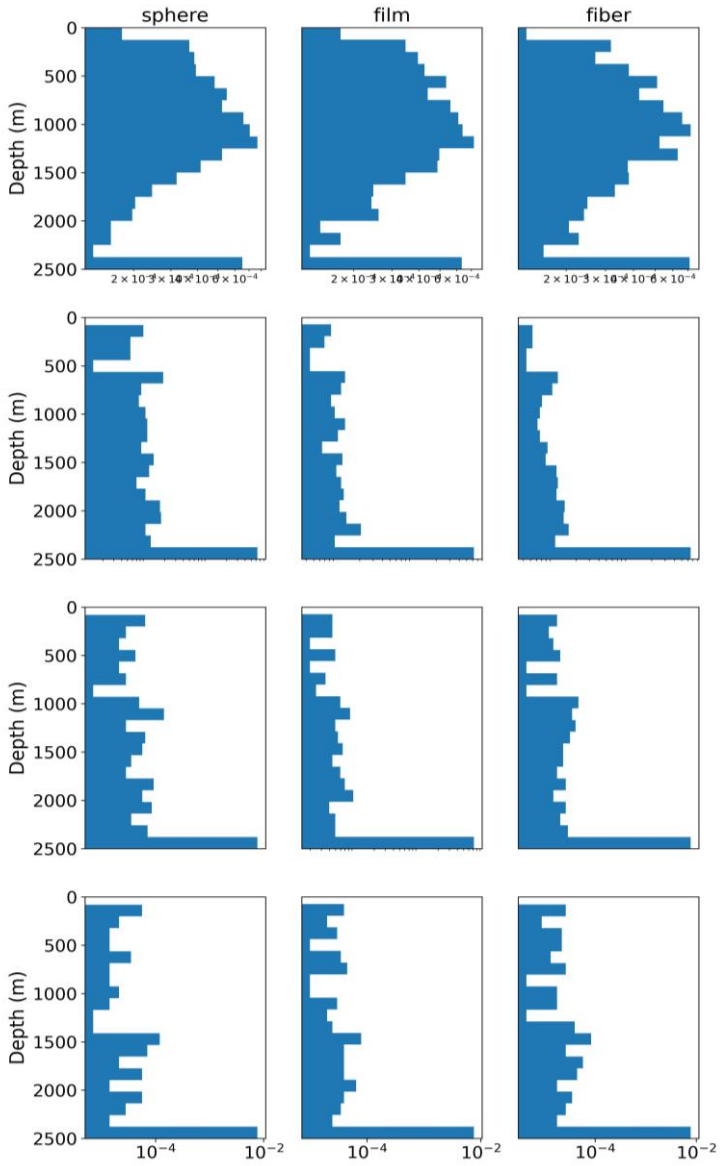
(D) Global Chlorophyll Concentration (December 2021)



(E) Vertical Density Increament in the Global Oceans (December 2021)



6. Fig. 6:



4.3. Expected run time for demo on a "normal" desktop computer

The expected run time depends on the number of simulated microplastics. On a "normal" desktop computer, each program make run for several hours to several days.

5. Instructions for use

5.1. How to run the software on your data

Users are encouraged to use their own data to run the model. They should place

their own data in the Data folder using the exact format and data organization style as the original datasets. To further adept new scenarios, the parameters within the model may need further modification. The model programs have provided enough instructions as well as references for these modification.

5.2. Reproduction instructions

See 4.1.