

MICRO 2024, 23 - 27 September 2024, Lanzarote

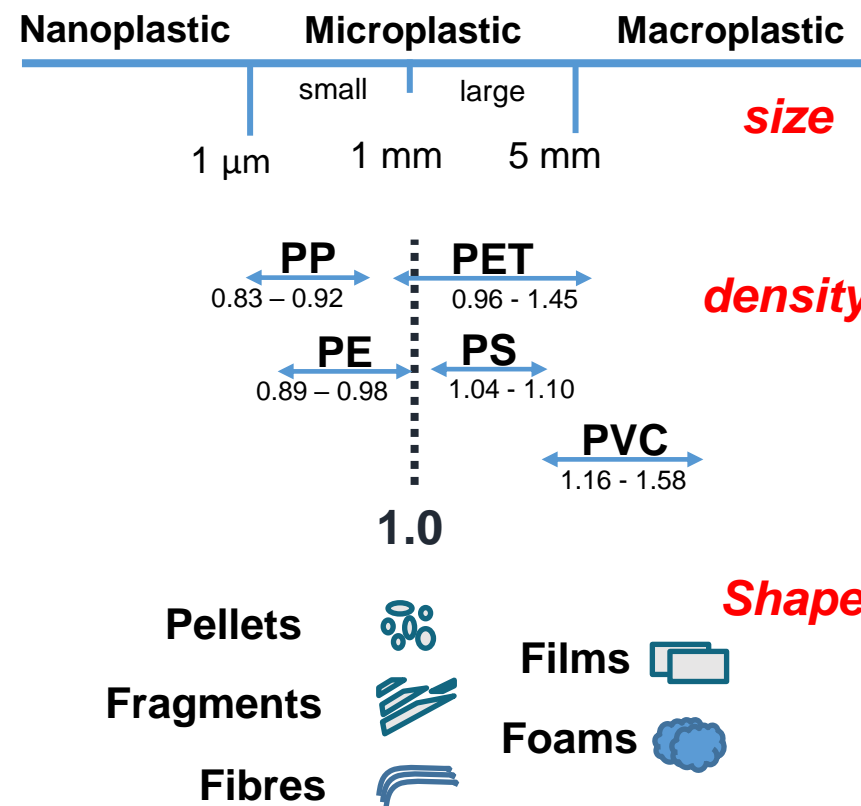
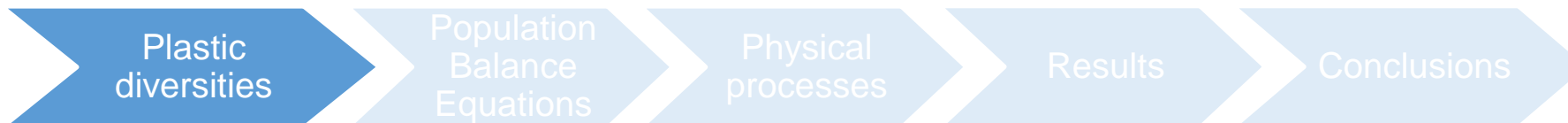
# Size-dependent microplastics transport in a sediment rich environment

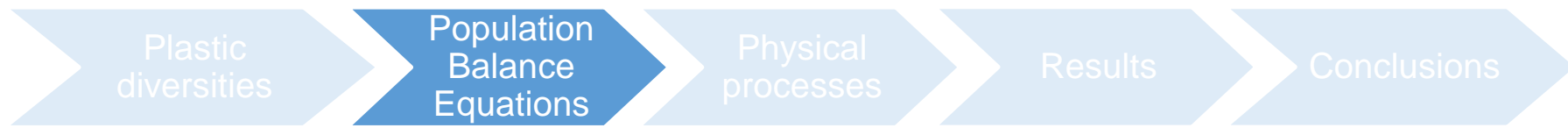
Nithin Achutha Shettigar<sup>1</sup>, Qilong Bi<sup>2</sup> and Erik A. Toorman<sup>1</sup>

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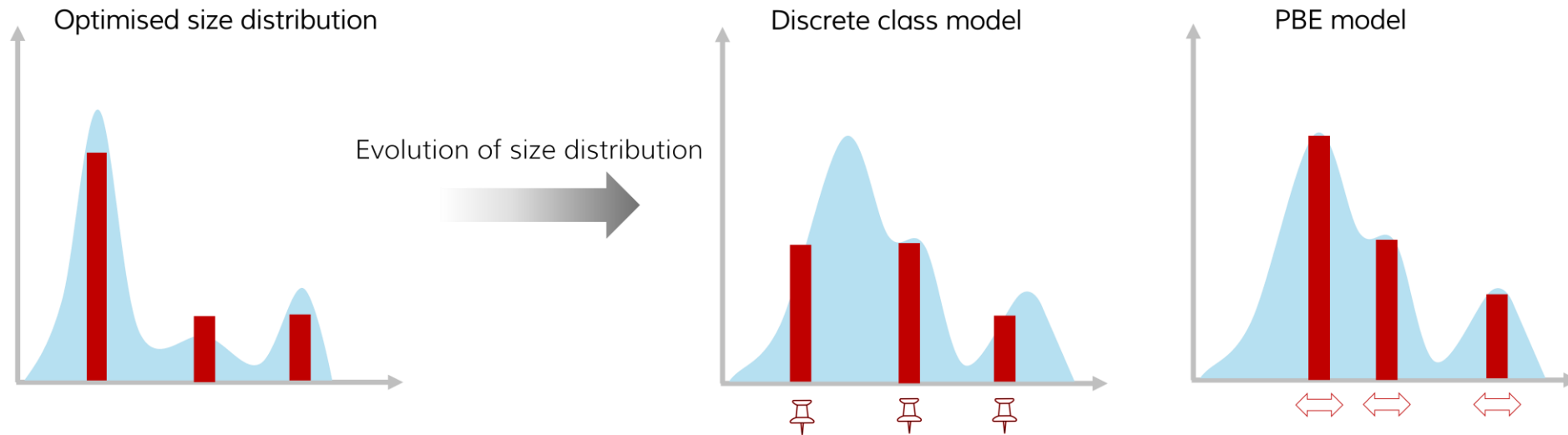






# Population Balance Equations

Modelling of the **dynamic evolution** of size distribution rather than the **restricted** size classes



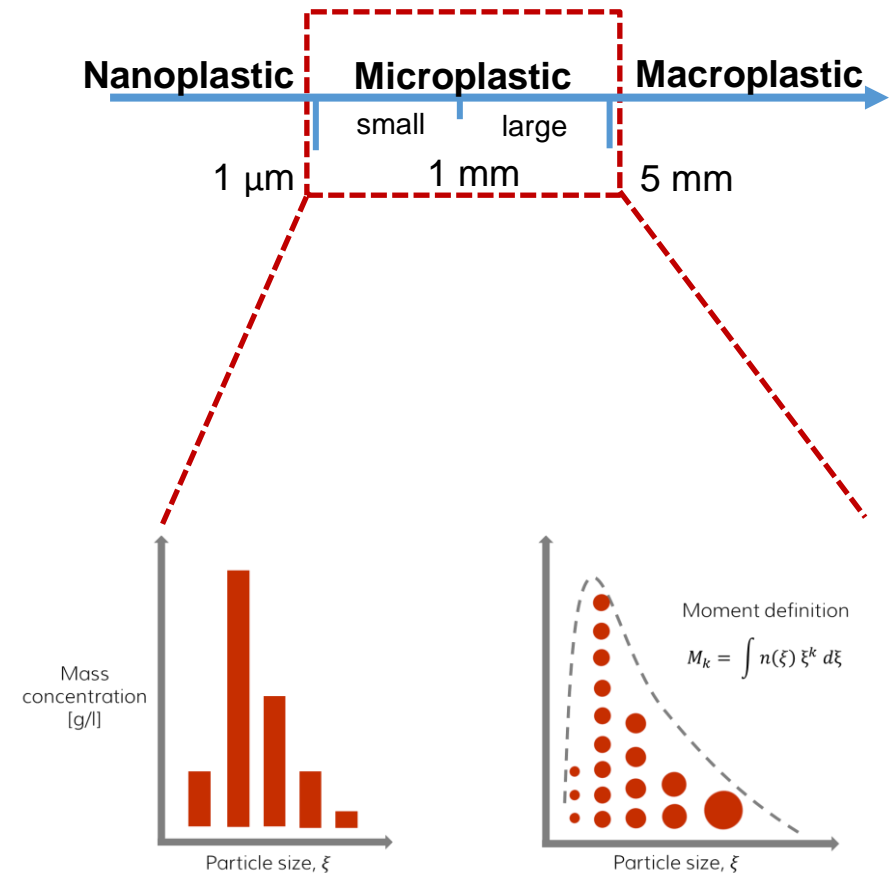
# Population Balance Equations

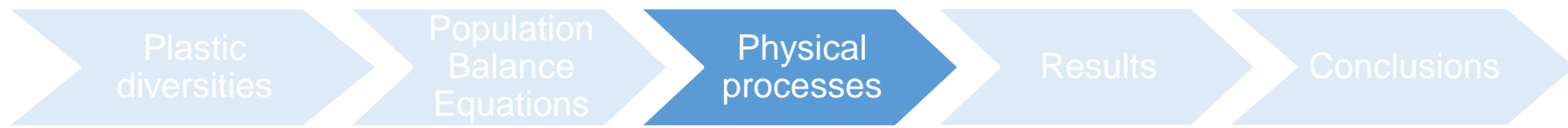
Modelling of the **moments** of size distribution rather than the mass or volume concentration

$$M_k = \int n(\xi) \xi^k d\xi$$

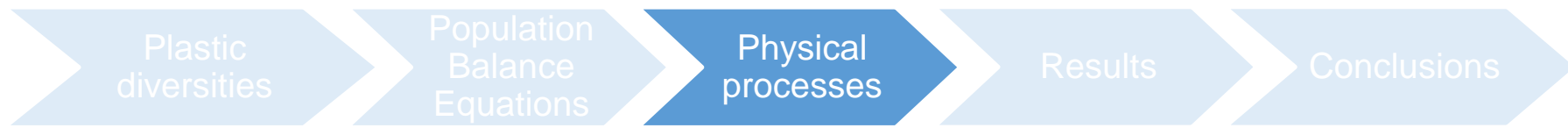
$$\frac{\partial M_k}{\partial t} + \frac{\partial U_x M_k}{\partial x} + \frac{\partial U_y M_k}{\partial y} - \frac{\partial}{\partial x} \left( D_x \frac{\partial M_k}{\partial x} \right) - \frac{\partial}{\partial y} \left( D_y \frac{\partial M_k}{\partial y} \right) = \text{sources} - \text{sinks}$$

$$U_k = \frac{\int U(\xi) n(\xi) \xi^k d\xi}{\int n(\xi) \xi^k d\xi} = \frac{\int U(\xi) n(\xi) \xi^k d\xi}{M_k}$$

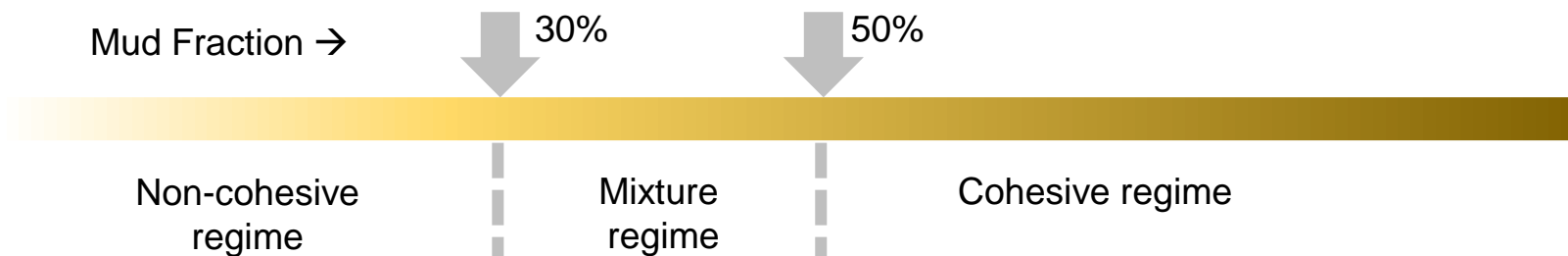
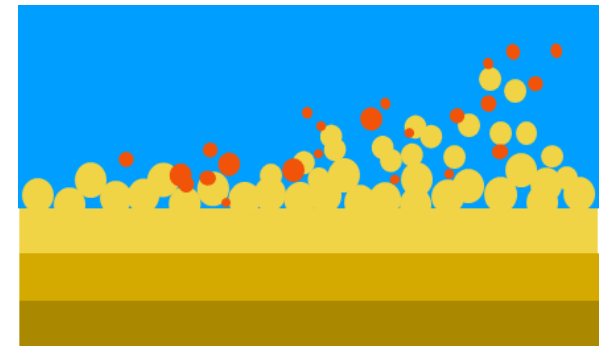
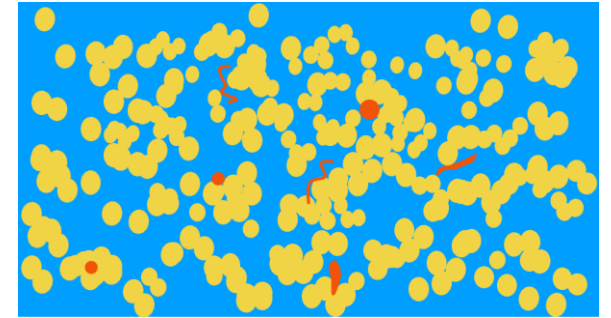


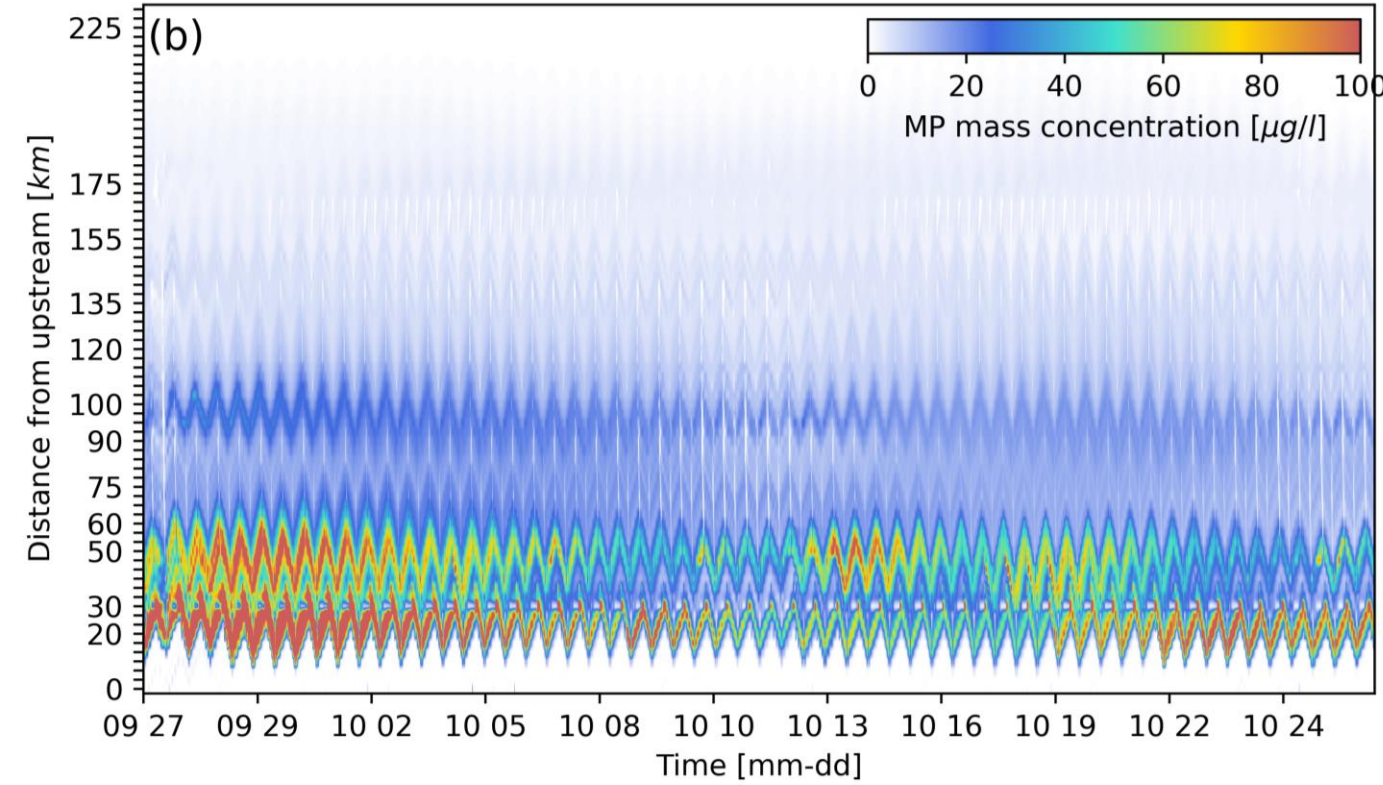
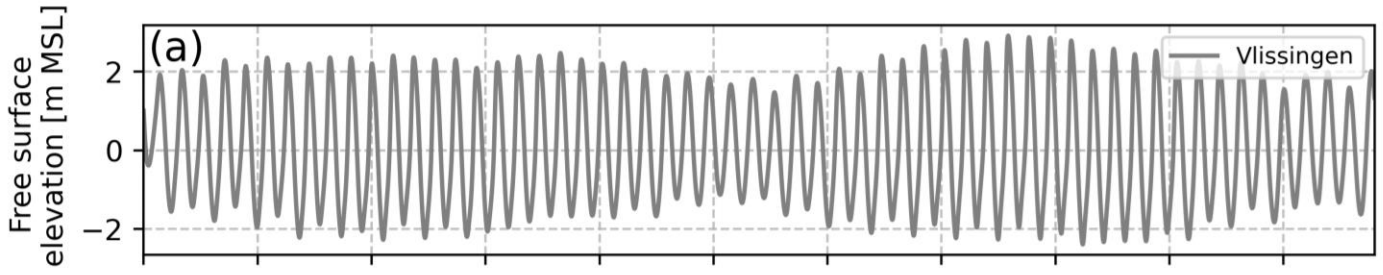


- Water motion: **currents** and **water levels**
- Mixed sand-mud **sediment** transport
- **μ-Plastics** transport modelling with PBE approach

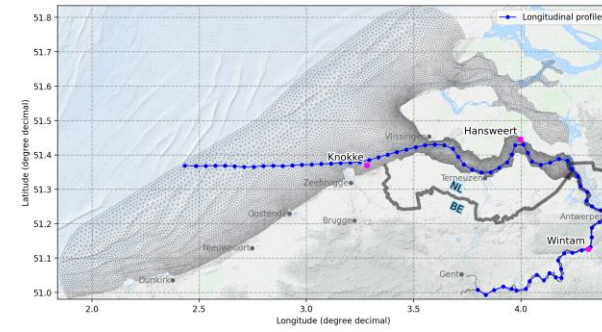
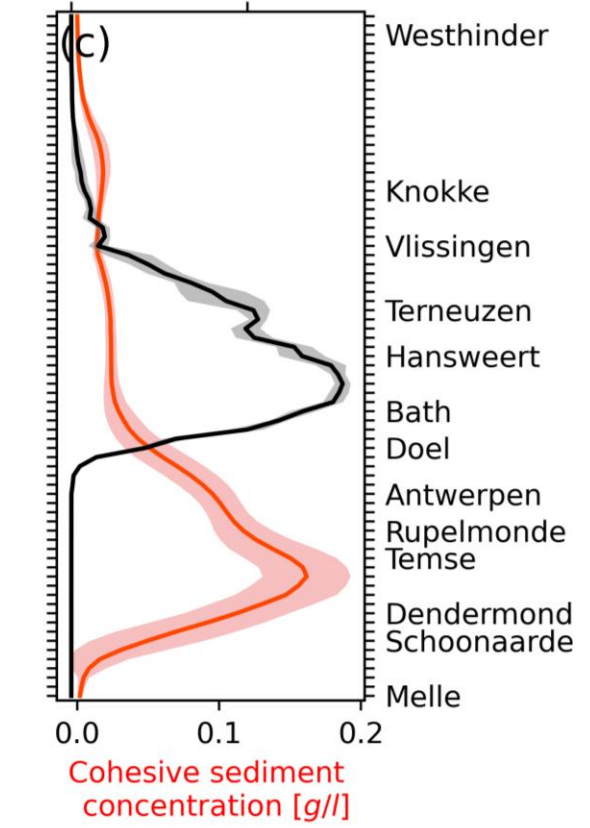


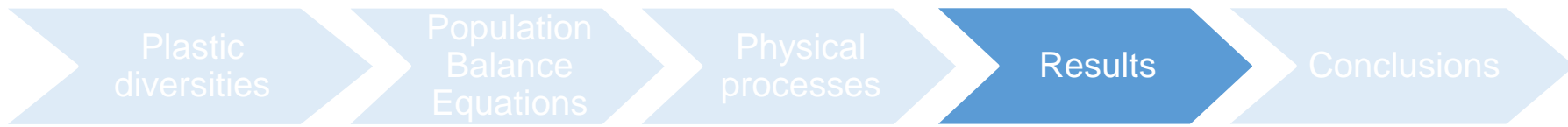
- Mud concentration affects the **deposition criteria** of the microplastics - **Suspension Capacity Theory** - Toorman (2000 & 2002)
- **Turbulence inertia** effect considered
- **Mixed sediment erosion criteria** is applied for the microplastics



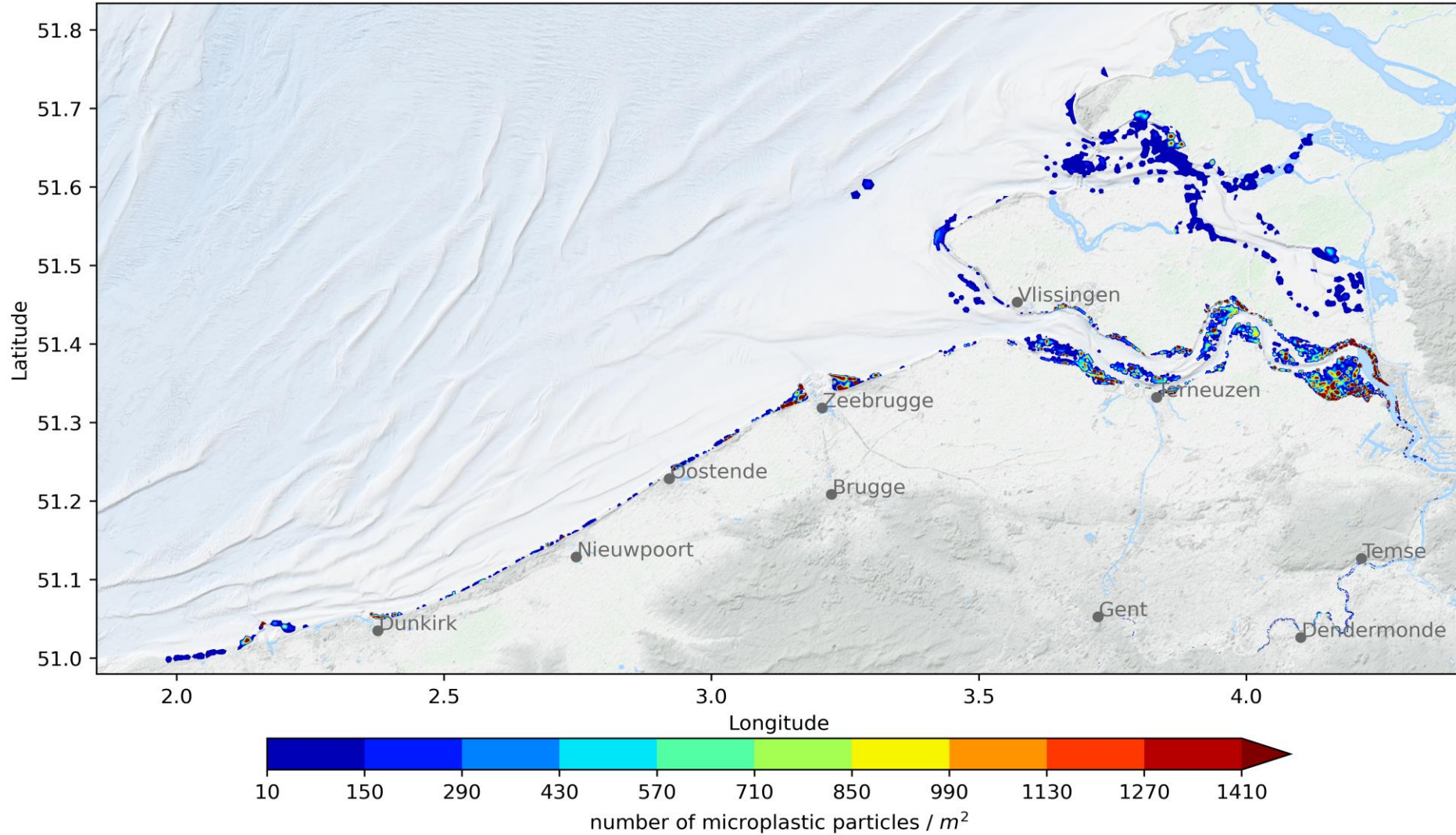


Tracer concentration [mg/l]

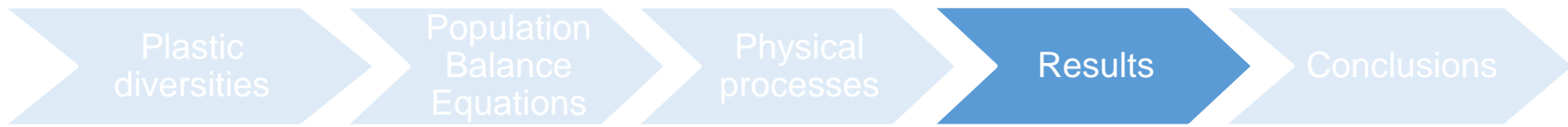




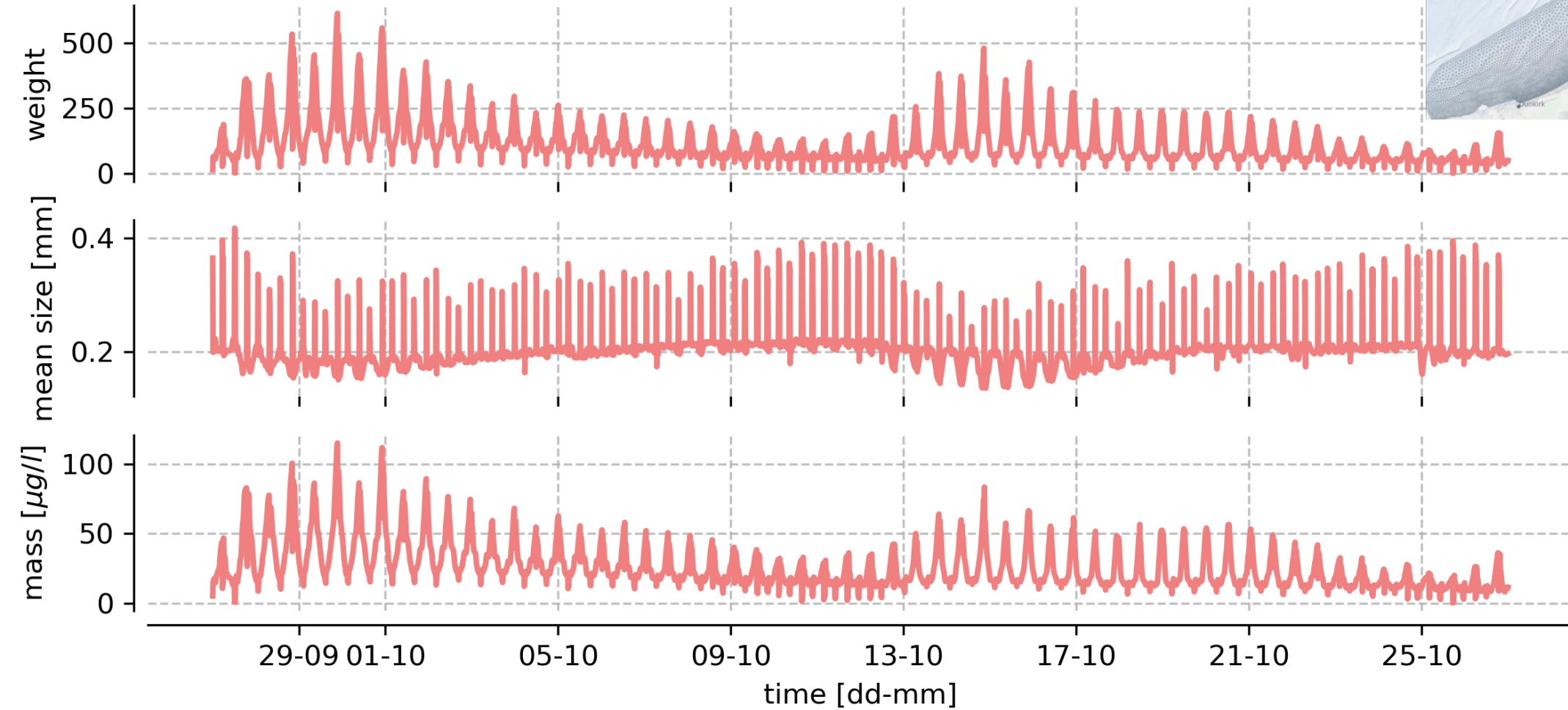
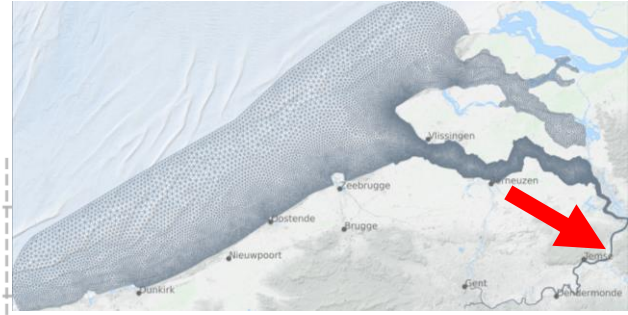
particle number concentration at the bottom at time: 2020-10-26 07:30:00

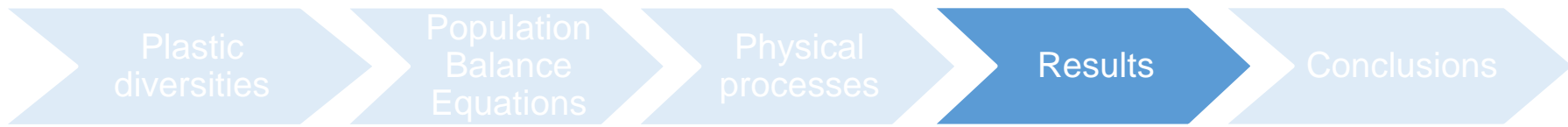




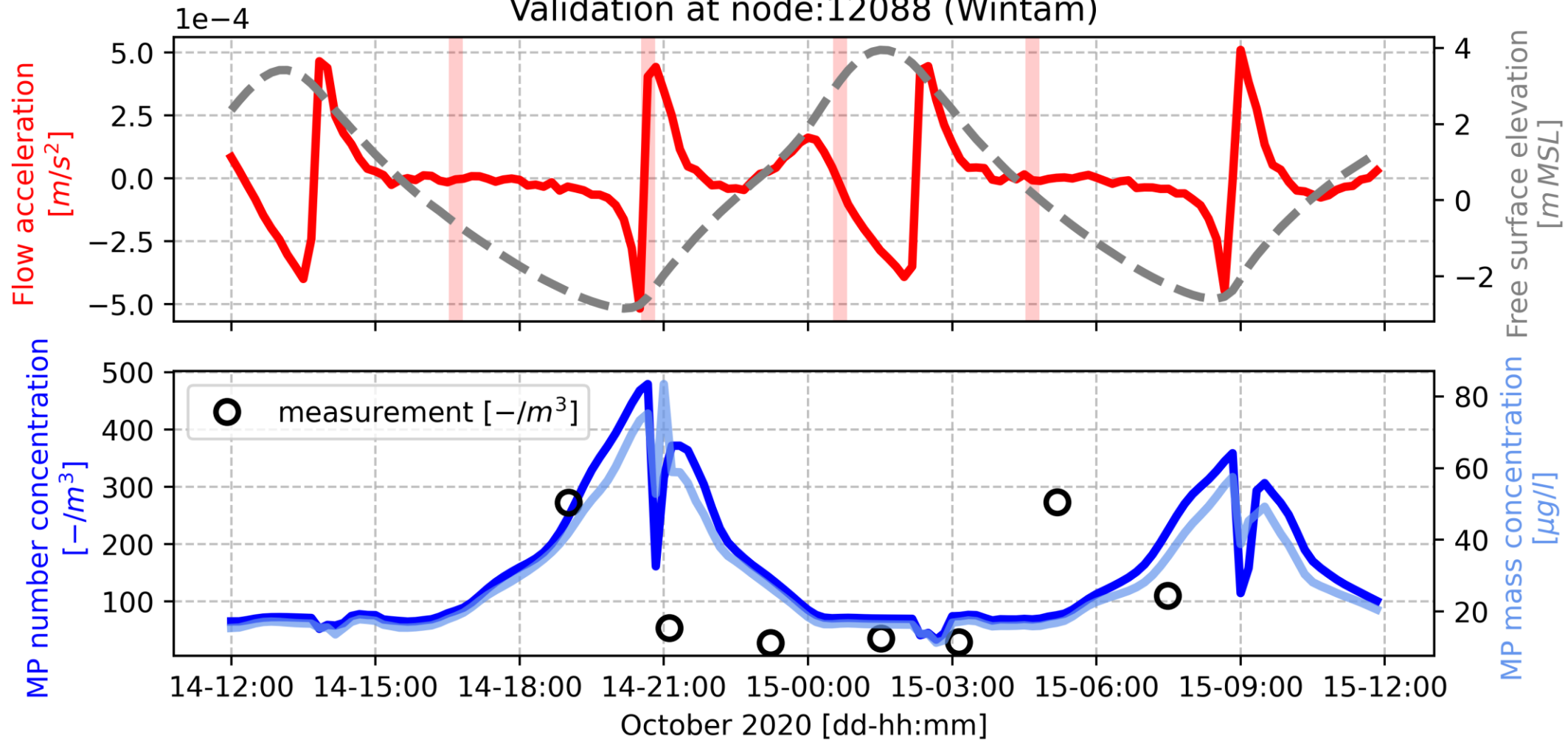


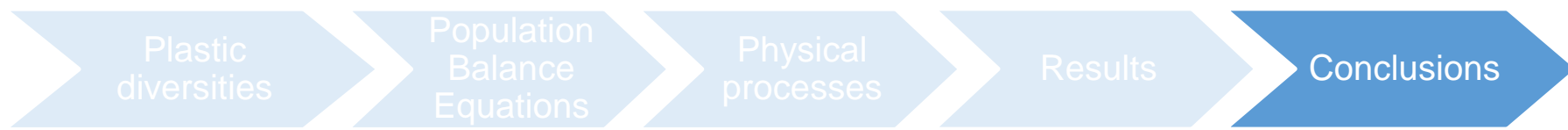
EQMOM result at node: 12088 (Wintam)





Validation at node:12088 (Wintam)





- PBE approach captures **dynamic evolution** of the size distribution
- Consideration of large **diversities** of microplastics is possible with PBE approach
- Applicable to other **particle transport processes** – flocculation, algae growth, other pollutant transports, etc.



Subscribed

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OCCURRENCE, FATE, AND TRANSPORT OF AQUATIC AND TERRESTRIAL CONTAMINANTS | August 27, 2024

# Assimilating Size Diversity: Population Balance Equations Applied to the Modeling of Microplastic Transport

Nithin Achutha Shettigar\*, Qilong Bi, and Erik Toorman

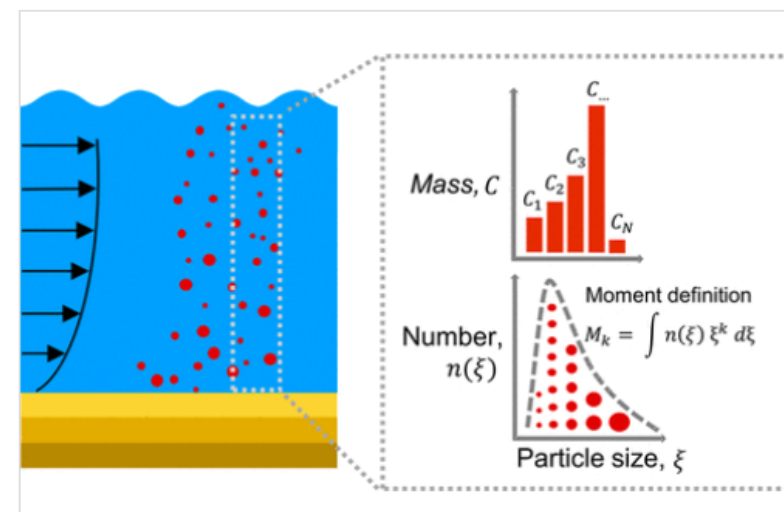
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Supporting Information (1)

KU Leuven

## Abstract

Modeling of microplastic (MP) transport in the aquatic environment is complicated by the diverse properties of the plastic particles. Traditional modeling methods such as Lagrangian particle tracking and Eulerian discrete class (DC) methods have limitations as they are not best placed to account for the diverse characteristics of individual particles, namely, size, density, and shape, which are crucial for determining the transport of MPs. In this work, we address the issue of particle size diversity by using the population balance equations (PBE) method. In addition to the advection–diffusion terms, the PBE transport equation involves a deposition sink term. Seven size classes of MPs are modeled in the DC method, which is compared to the PBE method. The evolution of particle size distribution is compared



# Thank you



# LABPLAS

