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Seasonal Variability of Microplastic Dispersion from Coastal and Riverine Inputs into the Northwestern Mediterranean: A High-Resolution Lagrangian Modelling approach

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AIMS

- Develop a **Lagrangian numerical model of microplastic dispersion** in the NW Mediterranean Sea
- **Quantify seasonal variability** in dispersion, export, and retention of microplastics from riverine and coastal sources
- Investigate how **vertical processes**, such as buoyancy and sinking, influence residence depth and export timescales

BACKGROUND AND STUDY AREA

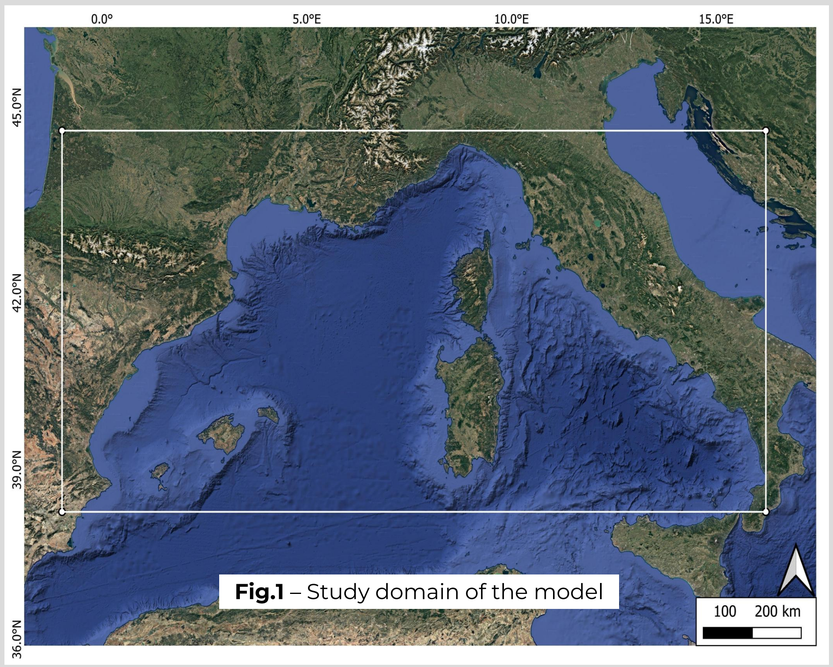

Fig.1 – Study domain of the model

Coastal and river inputs are key sources for **microplastics (MPs)** pollution into the marine environment

The **Mediterranean Sea** is highly affected by MPs contamination

Field sampling alone cannot accurately capture MP distribution, making **numerical modelling essential** for robust estimation of their transport and accumulation

HYDRODYNAMIC and LAGRANGIAN Particle-Tracking MODEL

ROMS[1] Hydrodynamic MODEL

DOMAIN
- Region: North-Western Mediterranean sea
- Horizontal Resolution : 1.3 km
- Vertical levels : 50 s-coordinate vertical levels, stretched for high surface resolution

INITIAL CONDITIONS

Temperature, Salinity, SSH, Currents, from CMEMS Med-MFC

FORCING
- Atmosphere: ERA5 reanalysis
- Surface waves/Stokes drift : CMEMS wave analysis
- Open Boundaries : CMEMS Med
- River discharge : Local datasets & Literature

PERIOD OF SIMULATION and timesteps
- 5 years multi-annual simulation (2020-2025)
- Time step: 60–120 s (CFL-stable)
- Output timestep: 1-3 h for Lagrangian forcing

OceanParcels[2] Lagrangian MODEL

- OceanParcels : A Python framework for **Lagrangian particle tracking** using ocean model outputs.
- Supports multiple grid types and flexible particle behavior with **efficient 3D advection**
- Computes trajectories with high-order integration for analyzing **dispersion and transport**

MPs source types :
- River Inputs
- Coastal cities
- Maritime traffic routes
- Homogeneous athmospheric deposition

MPs release scheme :
- **Scenario A –** River-only MPs fluxes
- **Scenario B –** Combined riverine + coastal emissions

Lagrangian Model validation against *in situ* observation

[1]**ROMS -** REGIONAL OCEANIC MODELING SYSTEM
Shchepetkin, A. F., & McWilliams, J. C. (2005). The regional oceanic modeling system (ROMS): a split-explicit, free-surface, topography-following-coordinate oceanic model. *Ocean modelling*, 9(4), 347-404.

[2]**OCEAN PARCELS –** «Probably A Really Computationally Efficient Lagrangian Simulator"
van Sebille, E., Lange, M., & Delandmeter, P. (2018, February). Making virtual particles behave like plastic: developing the OceanParcels Lagrangian Ocean Analysis framework. In *American Geophysical Union, Ocean Sciences Meeting* (No. 2161, pp. PO14A-2161).

EXPECTED OUTPUTS
- Horizontal dispersion & hotspots: seasonal maps showing where microplastics accumulate.
- Transport pathways & connectivity: how particles move between coastal and offshore regions.
- Vertical distribution: depth profiles affected by buoyancy, sinking, and mixing processes

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