Colloquium Final Report
N. 639 – Microplastic dispersion pathways

Dates and location: 06/05/2024 - 08/05/2025, Lerici, Italy

Chairperson Claudia Cenedese

Co-Chairperson Bruce Sutherland and Giuseppe Suaria

Conference fees

- **Regular registration fee 250 €**
- **Early registration fee 200 €**
- **Accompanying person registration fee 100 €**

What other funding was obtained? None

What were the participants offered? The registration fees included:
- **Digital book of abstracts.**
- **Two daily coffee breaks and three lunches.**
- **One dinner and one mixer.**

Number of members of Euromech (reduced registration fee) ?	**1**
Number of non-members of Euromech (full registration fee) ?	**38**
Number of accompanying persons	**3**

Confirmed participants

Stefano Aliani, CNR-ISMAR, Italy, "Stripes of plastics floating on the ocean"

Alberto Baudena, CNR-ISMAR, Italy, "The pathways of plastic beneath the Mediterranean Sea surface"

Francois Blanchette, UC Merced, USA, "Hydrodynamics Forces and Formation Mechanisms of Marine Aggregates"

Meike Bos, U. Utrecht, Netherlands

Daniel Carlson, Hereon, Germany, "Detecting intermittent surface convergence zones using aerial and satellite remote sensing and ship-borne X-band radar"

Claudia Cenedese, WHOI, USA, “Entrainment enhancement by particles in turbulent

plumes”

Sara Cloux, CSIC-UIB, Spain, "Mapping the Pathways of Marine Litter: Insights from 3D Ocean Trajectories and Vertical Dynamics"

Marco De Paoli, TU Wein, Austria, "Influence of shear Reynolds number on the transport and dynamics of microplastic fibers in turbulent channel flow"

Michael Denes, Utrecht U., Netherlands, "PlasticParcels – a ready-to-use tool for plastic dispersion simulations and parameterization development"

Michelle DiBenedetto, U. Washington, USA, "Sunlight and microplastics: how ocean surface dynamics control particle light exposure"

Jennifer Dingwall, U. Cambridge “Large eddy simulations of buoyant particles in a geostrophically adjusting front”

Michael Dotzel, MIT, USA, "Laboratory Experiments on Rigid Particle Aggregation in an Ekman-driven Can Flow"

Quiang Dotzel, U. Missouri - St Louis, USA

Annalisa Griffa, CNR-ISMAR, Italy

Rama Govindarajan, ICTS, Tata Institute of Fundamental Research, India, "Aspects of small-particle clustering"

Chisa Higuchi, Kyushu, U. Japan, "How much should we reduce plastic waste emission to avoid additional ocean plastic pollution by 2050s"

Matthew Hoffman, Rochester Inst of Tech, USA, "Modeling and measuring fate and shoreline deposition of microplastic in North American Lakes"

Atsuhiko Isobe, Kyushu, U. Japan, "A database of microplastic abundance across the world’s upper ocean"

Quentin Kriaa, U. Twente, Netherlands, "Transport and settling of microplastics in turbidity currents"

Mao Kuroda, Kyushu, U. Japan, "Small microplastics detected in the intermediate layer in the North Pacific Ocean: field surveys and possible pathways"

Adrien Lefauve, U. Cambridge, England, "An experimental testbed for environmental stratified turbulence and mixing"

Zhixuan Liu U. Cambridge “Transport of Gas Bubbles by Vortex Rings”

Eckart Meiburg, UC Santa Barbara, USA, "Exploring flocculation and transport processes of cohesive particulate matter via particle-resolving simulations"

Jessamy Mol, TU Delft, Netherlands, "A laboratory study of wave-induced transport in a rotating wave flume"

Andrea Paluselli, CNR-ISMAR, Italy, "Vertical distribution and transport of textile microfibers (MFs) in the Mediterranean water column"

Vincente Perez-Munuzuri, U. Santiago de Compostela. Spain, "Modeling Fragmentation of Plastic Particles"

Samantha Phan, OIST, Japan

Federico Pizzi, U. Politècnica de Catalunya, Spain, “Numerical and Laboratory Studies

of Marine Microplastics in upper-ocean turbulence”

Hugo Poncelet, IRPHE, U Aix-Marseille, France

Marie Poulain-Zarcos, École Centrale de Lyon, France

Larry Pratt, WHOI, USA, "Attraction and Accumulation of Microplastics in 3D Flows under Maxey-Riley Dynamics"

Nimish Pujara, U. Wisconsin-Madison, USA, "Coastal transport and beaching of microplastics"

Luz Andrea Silva Torres, U. Lille, France

Alfredo Soldati, TU Wein, Austria, "Full rotational dynamics of plastic microfibers in turbulence

Giuseppe Suaria, CNS-ISMAR, Italy

Laura Sunberg, Colorado State, USA, "Impacts of microplastic properties on transport by coastal flows"

Bruce Sutherland, U. Alberta, Canada

Mine Tekman, Alfred Wegener Inst, Germany, "Sources, Sinks and Transportation Pathways of Microplastic in the Arctic"

Gautier Verhille, IRPHE, France, "Dynamics of deformable particles in turbulent flows"

Andrew Woods, U. Cambridge, England, "Experiments on Microplastic-Sediment Interaction"

Scientific Report

Altogether there were 39 participants and 31 presentations. The full program is available in a separate document. Most importantly, there was ample time for informal discussions among the participants during coffee breaks, lunches and social activities. During and following many stimulating and diverse talks, attendees discussed the next steps going forward. The problem of predicting the pathways from sources to sinks in rivers and the ocean is vast.

Rama Govindarajan suggested a framework be developed to help our community synthesize ideas and provide focus for our research endeavors. Some suggestions for a framework include developing zeroth order equations, akin to ecological modelling that has lots of parameters.

Another idea was to develop box models that estimate fluxes of plastics from various sources (municipal waste, ocean dumping, etc.) to various reservoirs (rivers, coastal regions, open ocean, etc.) to various sinks (beaches, river sediments, abyssal floor, etc.). Some box models have previously been developed, but with less emphasis on plastic dispersion pathways. Aspirationally, as a zeroth order summary one would like to develop a box model that specifies the mass flux (Mton/year) of plastic released into various marine reservoirs from various sources, subdividing these into what fraction are buoyant and negatively buoyant and which are macroplastics and microplastics (shape could be

a further consideration). For each of these, the model also would specify the mass flux corresponding to the transformation of particles from buoyant to negatively buoyant, from macroplastic to microplastic, and transport from one type of reservoir to another (e.g. from coastal to open ocean). Finally, the model would specify the mass flux from various reservoirs to sinks.

Although some studies have already attempted to estimate mass (if not, volume) fluxes in a narrow range of the above cases, great uncertainty exists even in those cases: is there even missing plastic? After the final discussion, it was generally felt that developing a box model providing numbers for mass fluxes would be overambitious at this time.

Keeping in mind our original goal to help provide focus to our diverse collection of research endeavors, a suggestion put forward by Michael Denes following the discussion was to create a living document in which members of our community could upload and download references to published work related to various transport pathways. The document could also include links to observational databases (e.g. the Atlas of Ocean Microplastics) and modelling resources (e.g. PlasticParcel). To this end, we have created a GoogleDoc that can be accessed by anyone with the following link:

https://docs.google.com/document/d/12_tIDJdJO8gLpz0FfqlXMkZ9LcjbXFFyqbuQLm8HIBs/edit?usp=sharing

This document contains links to observational and modelling resources as well as references to published articles related to microplastic dispersion pathways. References are grouped as they relate to pathways from various sources to various marine reservoirs to various sinks, as well as transformation pathways from macroplastics to microplastics and from buoyant to negatively buoyant particles. Processes within various marine reservoirs can also be included.

As a crude guide, net sources, reservoirs, and net sinks are subclassified as follows:

- Net sources
  - Municipal waste
  - Storm drains
  - Runoff
  - Dumping from land
  - Dumping at sea
  - Atmosphere (net source of plastics, but also a partial sink)
- Reservoirs
  - Rivers and estuaries
  - Swash zone

    - Near coast
    - Western boundary currents
    - Open ocean - near surface
    - Open ocean - thermocline
    - Open ocean - abyss
- Sinks
    - River and estuary beds
    - Beaches
    - Near shore sediments
    - Continental margins
    - Abyssal floor

We thank Euromech for making the meeting possible and for financial and organizational support.

Number of participants from each country

COUNTRY	PARTICIPANTS
Italy	**5**
Spain	**3**
United States	**10**
Austria	**2**
France	**3**
United Kingdom	**4**
Japan	**4**
Canada	**1**
India	**1**
Netherlands	**4**
Germany	**2**
TOTAL	**39**