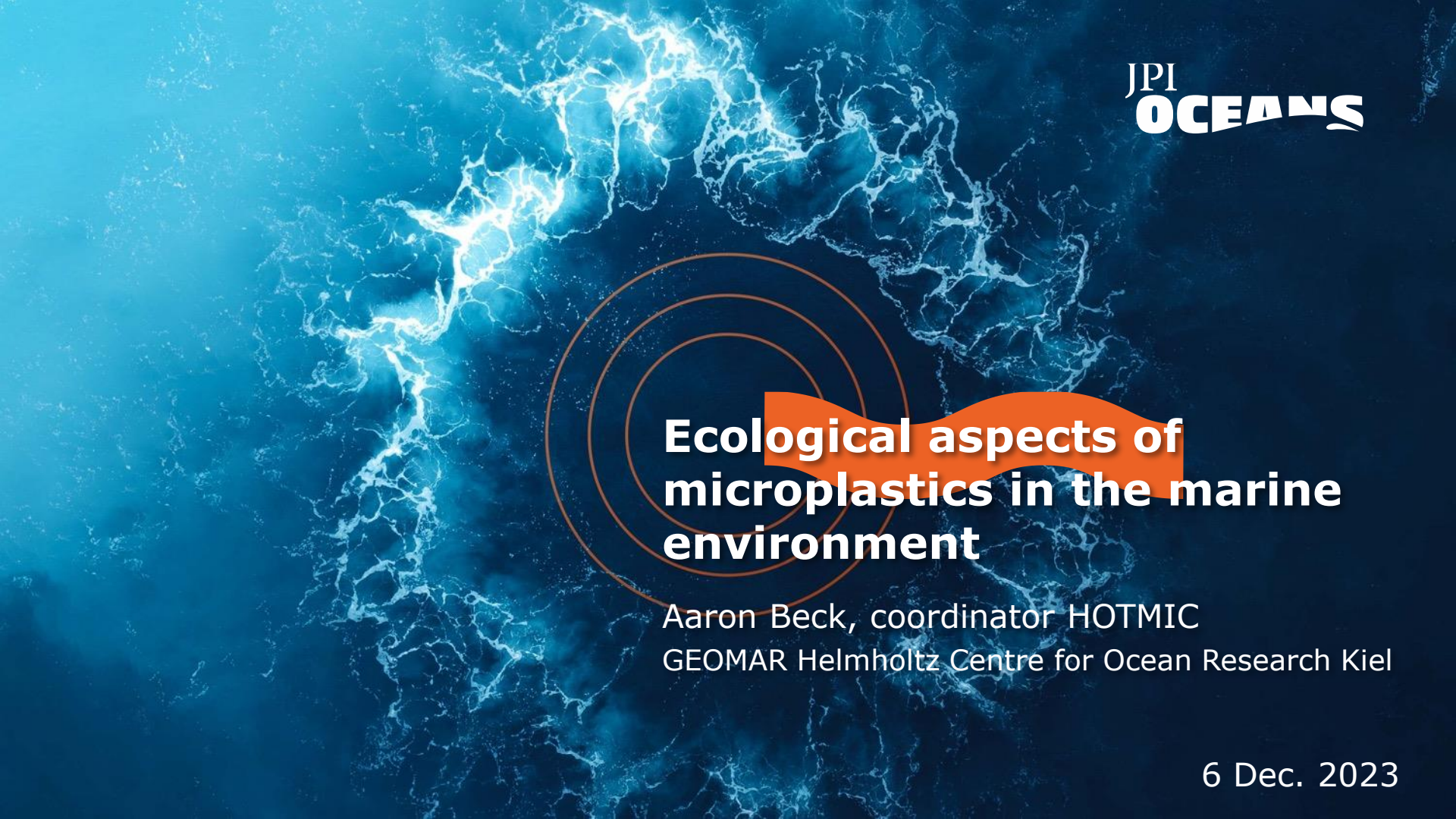


Ecological aspects of microplastics in the marine environment

Aaron Beck, coordinator HOTMIC
GEOMAR Helmholtz Centre for Ocean Research Kiel

6 Dec. 2023

Ecological aspects of microplastics 2020-2023

Preceded by four projects (2016-2019) that sought to:

- Define baselines and standards for microplastics analysis
- Understand ecotoxicological effects of microplastics
- Investigate weathering of plastics in marine waters

PLASTOX

WEATHER-MIC

BASEMAN
MICROPLASTICS ANALYSES IN EUROPEAN WATERS

EPHEMARE
ECOTOXICOLOGICAL EFFECTS OF MICROPLASTICS IN MARINE ECOSYSTEMS

Focal points of the new projects:

- New sampling and analytical methodologies
- Identification, characterisation and quantification of the major microplastic sources
- Transport, fluxes, and fate of microplastics in the marine environment
- Degradation and weathering of plastics in the marine environment
- Risk assessment and eco-toxicological effects

JPI Oceans projects consist of EU/international consortia, implemented exclusively with national funding

Ecological aspects of microplastics 2020-2023

ANDROMEDA · FACTS · HOTMIC · i-plastic · Microplastics · RESPONSE

6 projects

17 nations

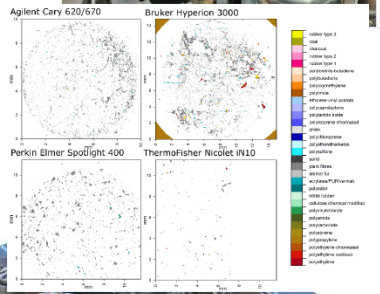
72 partner institutions, organizations, & companies

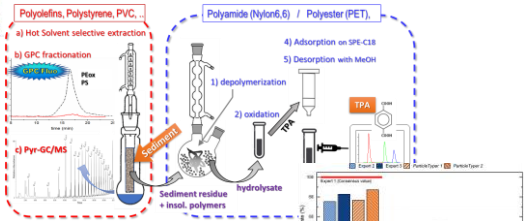
Methods – harmonization, automation, innovation

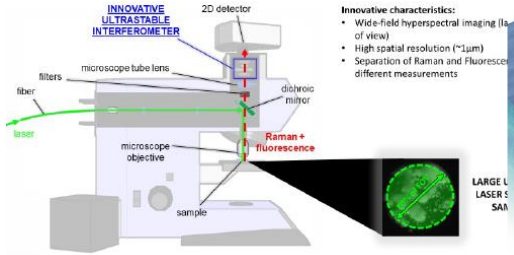
- **Automation** of existing methods
- Comparison of spectroscopic and mass-based methods
- Development of **new methods**: tires, boat paints, ADDITIVES
- Method harmonization is challenging
- Different methods determine different microlitter properties
- **...no silver bullet!**

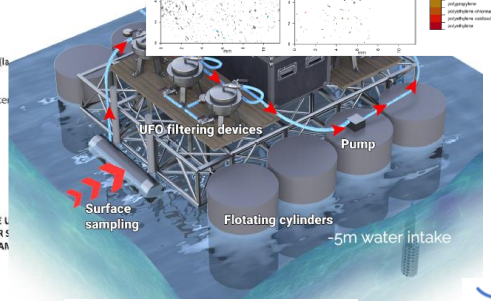
Implementation and validation of Standard Operating Procedures (SOPs) for sample treatment and analysis

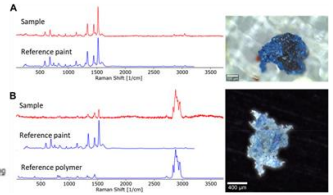
SOPs are publicly accessible and citable: https://doi.org/10.5281/zenodo.8313017

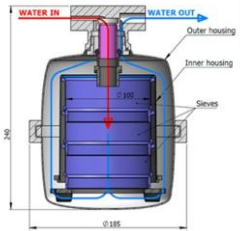










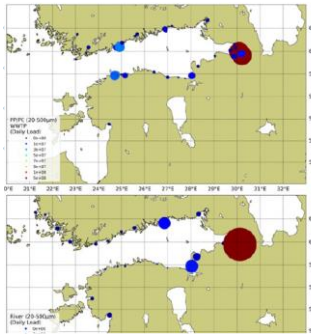


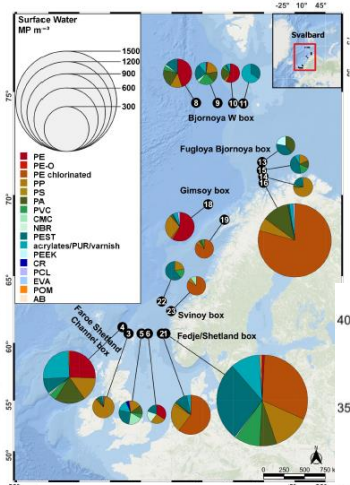
RESPONSE FACTS HOTMIC ANDROMEDA

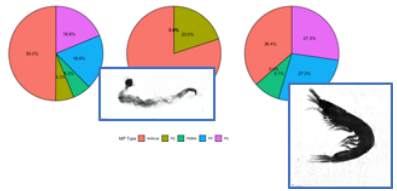
Widespread distribution and multiple controls on flux

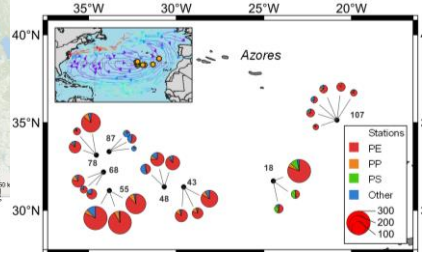
- Microplastic pollution is **ubiquitous:** tropical/temperate/polar, estuarine/coastal/oceanic, surface/shallow/deep water, water/sediments/biota
- Distribution is **heterogeneous** in space and time
- **Plastics are fractionated** during transport from sources to sinks
- Accumulation in sediments mimics global production
- Data feed into **monitoring efforts** of the Marine Strategy Framework Directive

i-plastic

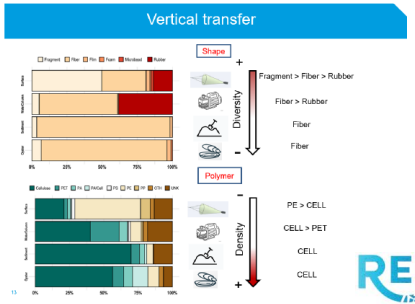


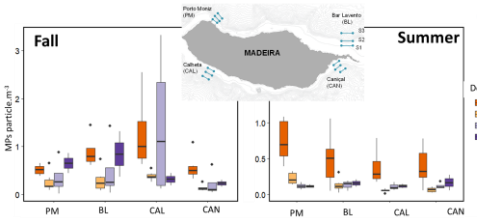






FACTS



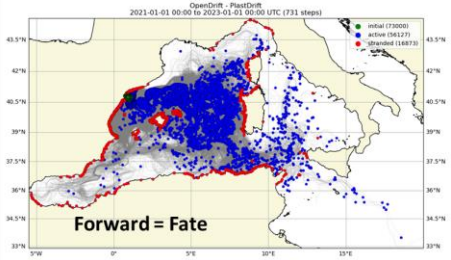


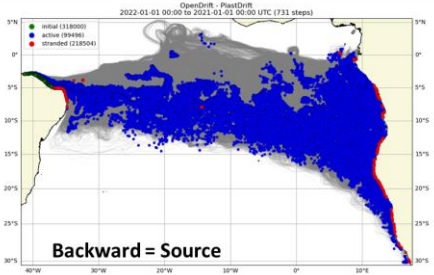
HOMIC

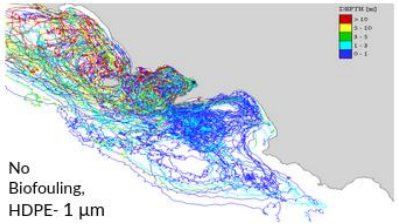
RESPONSE

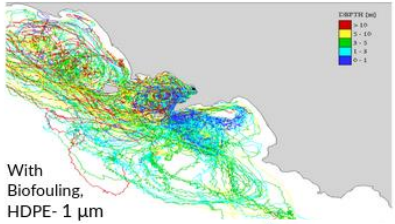
Models of MP distribution and transport are improving but still limited

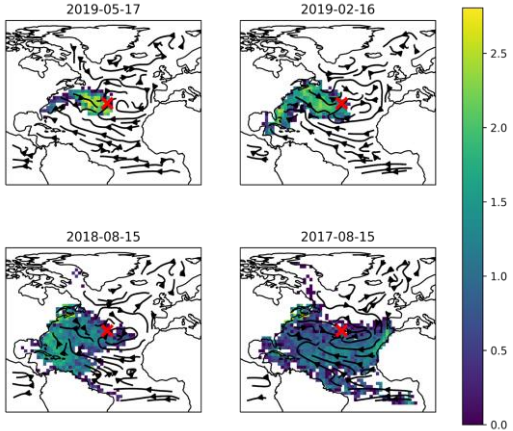
- Ocean physics varies among ocean basins – need basin specific models
- Microplastics sink, and **vertical transport** is important
- **More data** needed to validate and refine models – automated methods will help
- Additional data from citizen science initiatives?









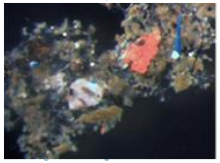


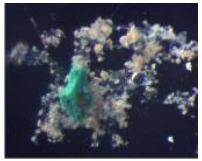
i-plastic

HOTMIC

Microplastic ingestion, impacts, utility(?)

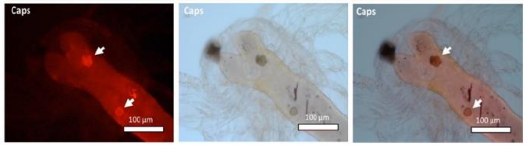
- Widespread uptake of MPs, but **evidence for discrimination**
- Microbial community, zooplankton and zoobenthos influence environmental fate of MPs and NPs
- Filter feeders have potential to act as **bioremediators**
- Other bio-inspired microplastic collectors show promise





i-plastic

RESPONSE

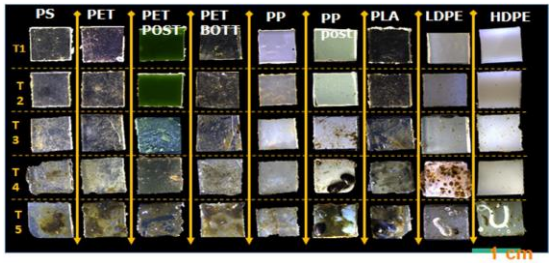


Paraleucilla magna

Mytilus galloprovincialis

Sabella spallanzanii

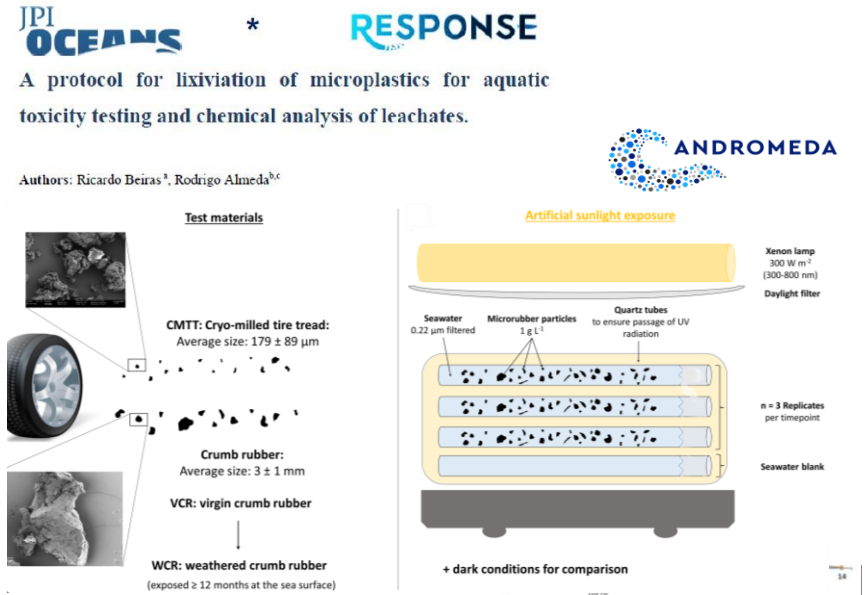
Phallusia mammillata

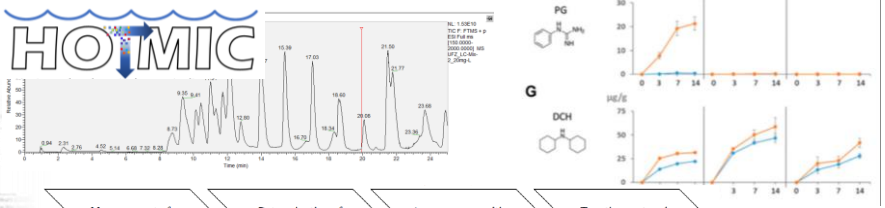


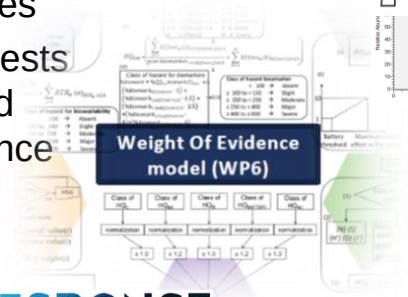
HOTMIC

Additive chemicals and toxicity

- Chemical characterization of leachates in plastics, tire rubber, and coatings
- Sunlight enhances **leaching & transformation** of organic chemicals from tire particles
- Tire rubber still leaches chemicals after 12 months → long-term chemical source
- Chronic and long-term toxicity under **ecologically-relevant** exposures
- Standardized ecotoxicological tests and weighted criteria for Hazard Quotients and Weight-of-Evidence framework







RESPONSE

FACTS

DMVCH (2,4-Dimethyl-4-vinylcyclohexene)

Summary and Recommendations

- Marine microplastics are **ubiquitous**
  - Important source of **micro- and nano-plastics** from macroplastics
  - Marine pollution tracks production & use –
    improve by reduction, recycling (circular economy), and waste control
- Small microplastics are hard to sample, measure, monitor
  - Standardized methods and **automation** will help
- **Chemical additives** can be highly toxic, especially those in car tires
  - Bio- and compostable- plastics may also be highly toxic
  - Additive mixtures **highly complex,** so source of toxicity not always known

- Continued **source control** is critical!
- Need further development of **effective and efficient monitoring tools**
- Future focus on **chemical toxicity** – need cooperation with industry
  - Simplified assessment by predictive toxicity models, rapid chemoassays...

JPI Oceans projects supported by national funding agencies:

JPI OCEANS

Thank you for your attention

Aaron Beck | ajbeck@geomar.de