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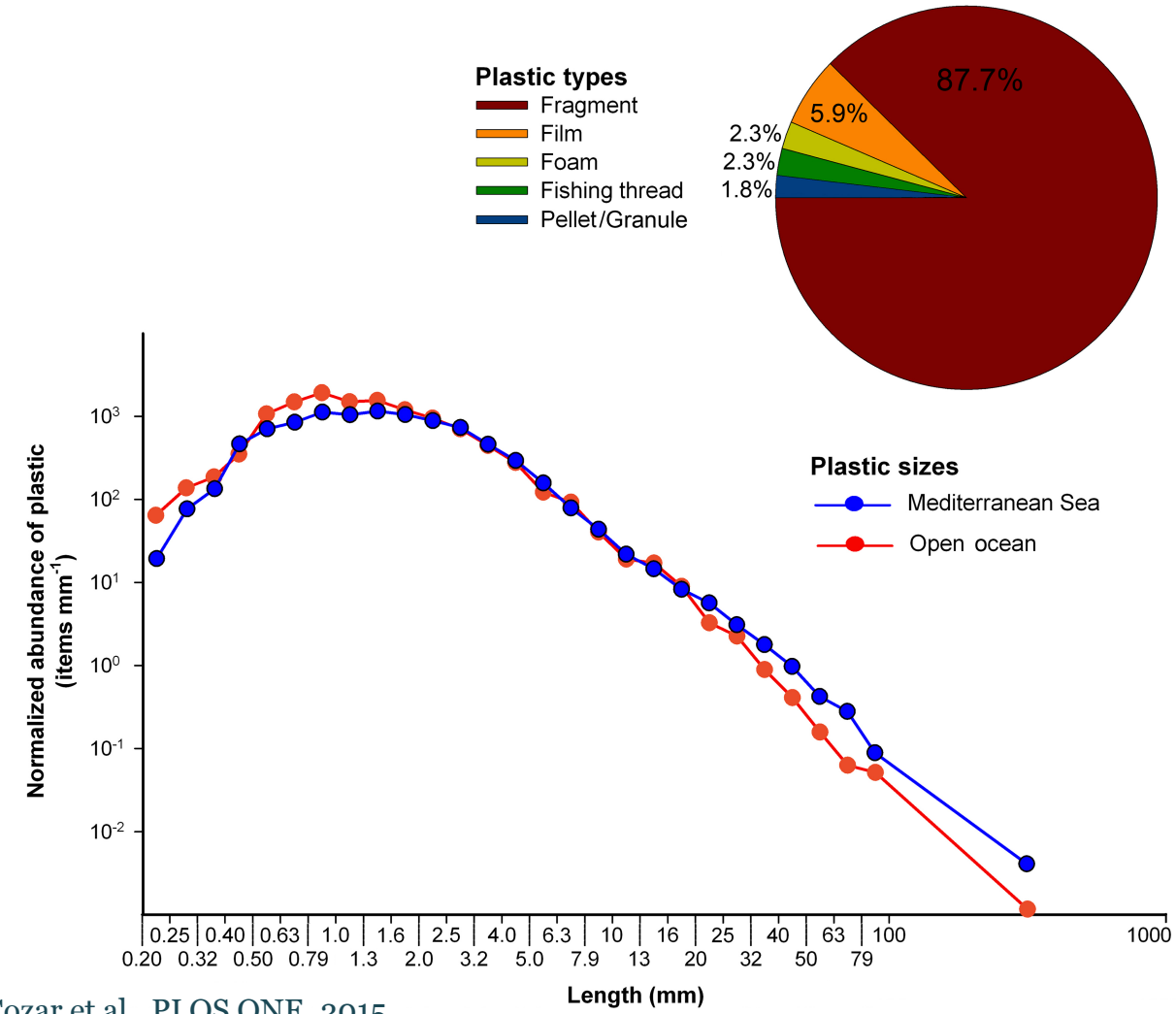
Biogenic polymer aggregation drives the export and vertical dynamics of small microplastics in the North Atlantic Gyre

Luisa Galgani[*1,2], Isabel Goßmann[3], Barbara Scholz-Böttcher[3], Zhanfei Liu[4], Xiangtao Jiang[4], Lindsay Scheidemann[1], Cathleen Schlundt[1], and Anja Engel[1]

[1]GEOMAR Helmholtz Center for Ocean Research Kiel, Germany
[2]Harbor Branch Oceanographic Institute of Florida Atlantic University, USA
[3]Institute for Chemistry and Biology of the Marine Environment (ICBM), Carl von Ossietzky University of Oldenburg, Germany
[4]The University Of Texas at Austin, Marine Science Institute, USA

*lgalgani@geomar.de / lgalgani@fau.edu

Where is all the plastic?

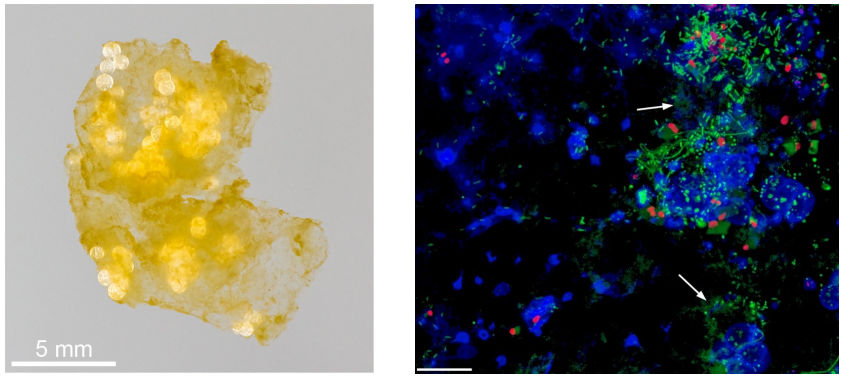


Cozar et al., PLOS ONE, 2015

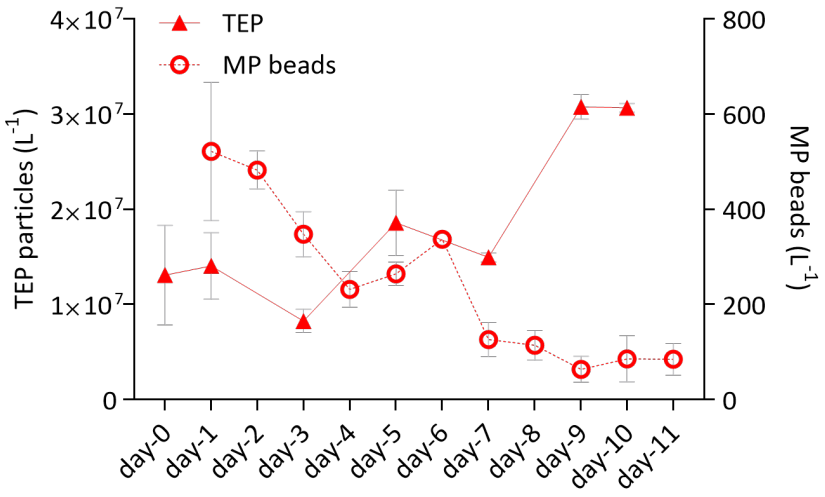
- In 2010, between 4 and 12 million metric tons of plastic reached the oceans (Jambeck et al., Science, 2015)
- Observations report "5.25 trillion plastic particles weighing 268,940 tons are currently floating at sea", with the two Northern Hemisphere oceans containing 55.6% of particles and 56.8% of plastic mass (Eriksen et al., PLOS ONE, 2014)
- Particles < 300 µm are possibly "a critical and largely underexplored constituent of the oceanic plastic inventory" especially at great depths (Zhao et al., GCB, 2022)

A biological plastic sink?

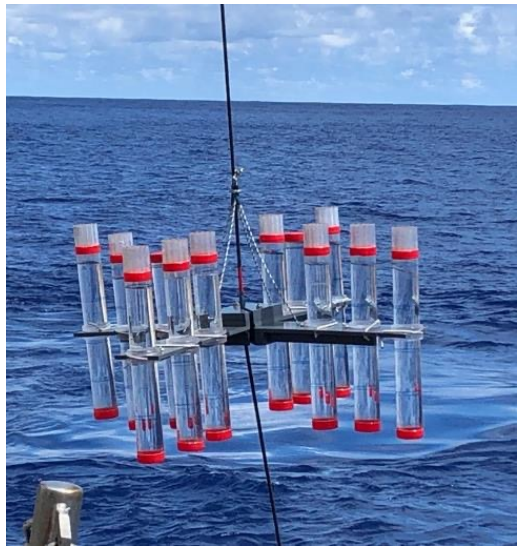
- Microplastics rapidly coagulate with biogenic particles, and the formation of microbial biofilms determines particles' fate in the marine environment (Michels et al. Proc. R. Soc. B, 2018)
- Microplastics can increase the production of organic carbon and its aggregation into gel particles: this has implications on microplastics transport in the ocean (Galgani et al., Env. Res. Lett., 2019)
- "[..] high potential of marine aggregates to remove microplastics from the ocean. This pathway, through marine snow and zooplankton fecal pellets, has been observed in controlled conditions, but not assessed at a global scale." (Kvale et al., Front. Mar. Sci., 2020)

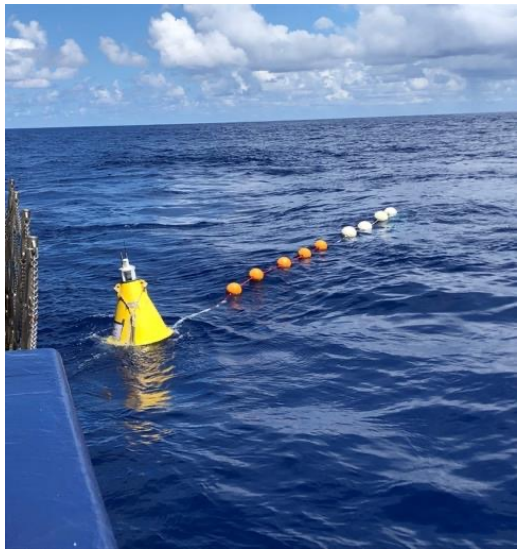


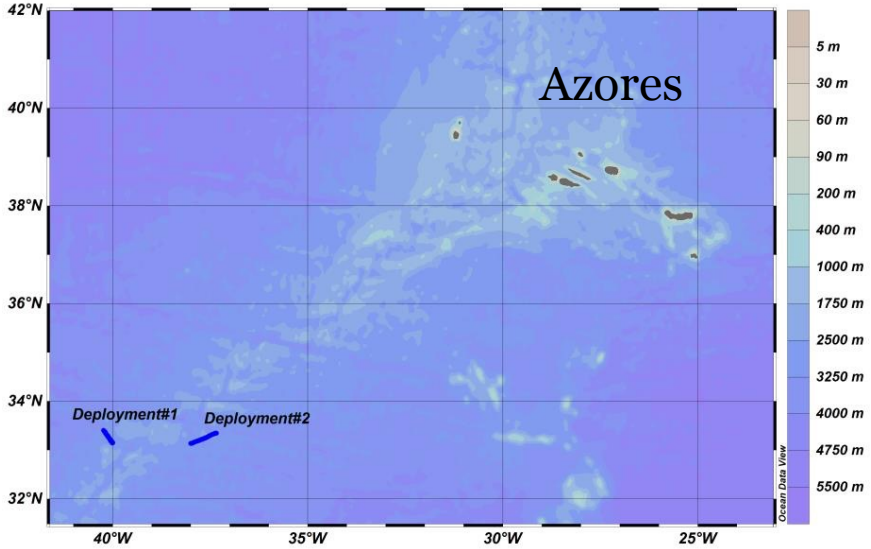
Michels et al., Proc. R. Soc. B, 2018



Galgani et al., Env. Res. Lett., 2019





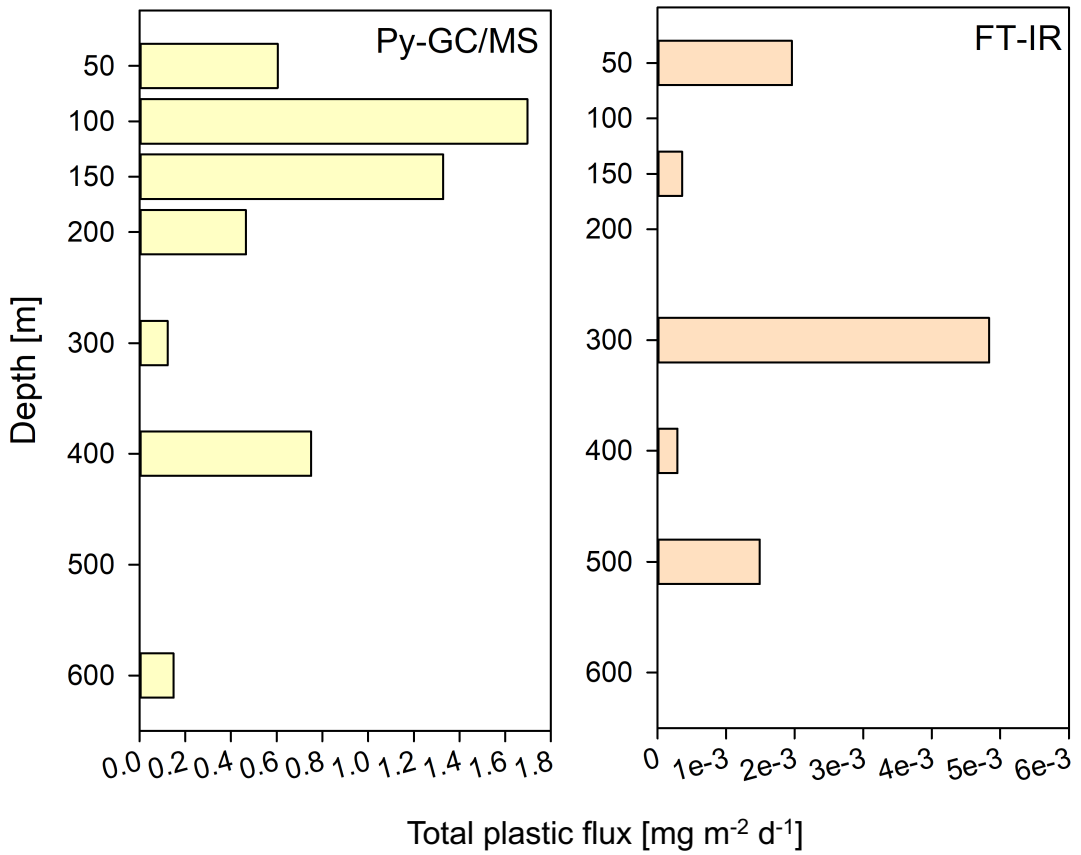


Galgani et al., in prep.

Surface tethered drifting sediment traps in the North Atlantic Gyre

- Export fluxes of sinking plastic particles were quantitatively assessed during two deployments
- 12 traps per array (10 samples + 2 blanks), 1 array per depth;
- 8 depths : 50 m, 100 m, 150 m, 200 m, 300 m, 400 m, 500 m, 600 m;
- 5 days free drifting and recovery, between 13 and 15 nm from deployment;
- Pre-screened material: < 500 µm

FT-IR and Py-GC/MS for plastic analysis

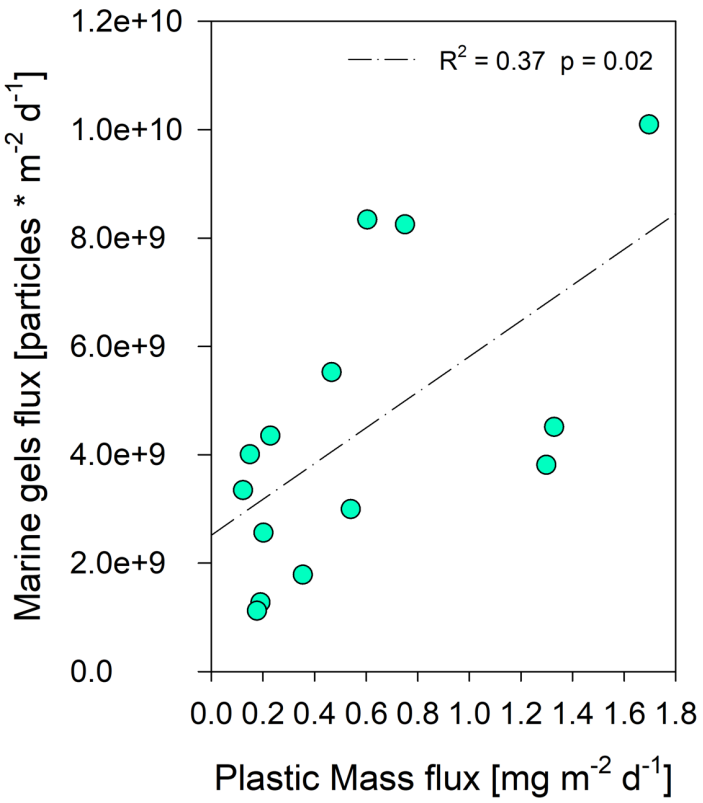


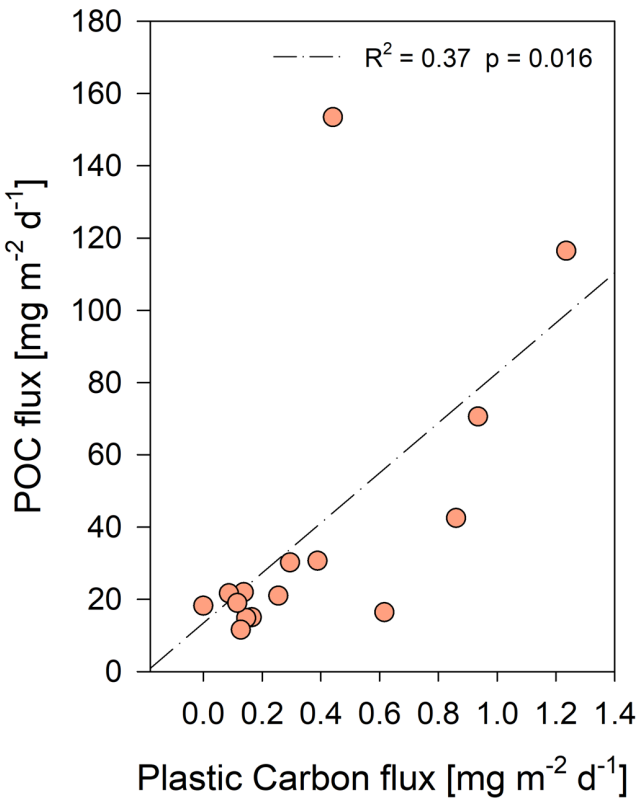
Galgani et al., in prep.

In our study:

- Py-GC/MS for particles > 10 µm;
- FT-IR for particles > 20 µm;
- We found about 0.9 ± 1.4 particles L^{-1},of 106±116 µm in size (FT-IR);
- By mass, plastic analyzed by Py-GC/MS is about 10^3 times larger than FT-IR;
- There might be a large fraction between 10 and 20 µm included in Py-GC/MS analysis;

Plastic export along with biogenic compounds





- Plastic mass and carbon in the range 10 µm – 500 µm (Py-GC/MS) strongly interacts with biogenic components: marine gels and Particulate Organic Carbon;
- In our study, there might be a large fraction of particles in the range 10 - 20 µm embedded into sinking particles;
- This interaction is what we think drives most plastic export to the deep ocean and the “biological sink” of these particles.

Galgani et al., in prep.

Thank You for your attention!

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Questions/feedbacks: lgalgani@geomar.de