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# First evidence of plastic fallout from the Great Pacific Garbage Patch

**Matthias Egger, Fatimah Sulu-Gambari & Laurent Lebreton - EGU2020**



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## Publication coming soon..

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- This study has been accepted for publication in *Scientific Reports*:
  - Egger, M., Sulu-Gambari, F., and Lebreton., L. (in press) First evidence of plastic fallout from the North Pacific Garbage Patch, *Scientific Reports*
- Expected publication date: May 6<sup>th</sup>, 11 am (CEST)
- Link to open access article (active on publication): [www.nature.com/articles/s41598-020-64465-8](http://www.nature.com/articles/s41598-020-64465-8)

**SCIENTIFIC**  
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natureresearch

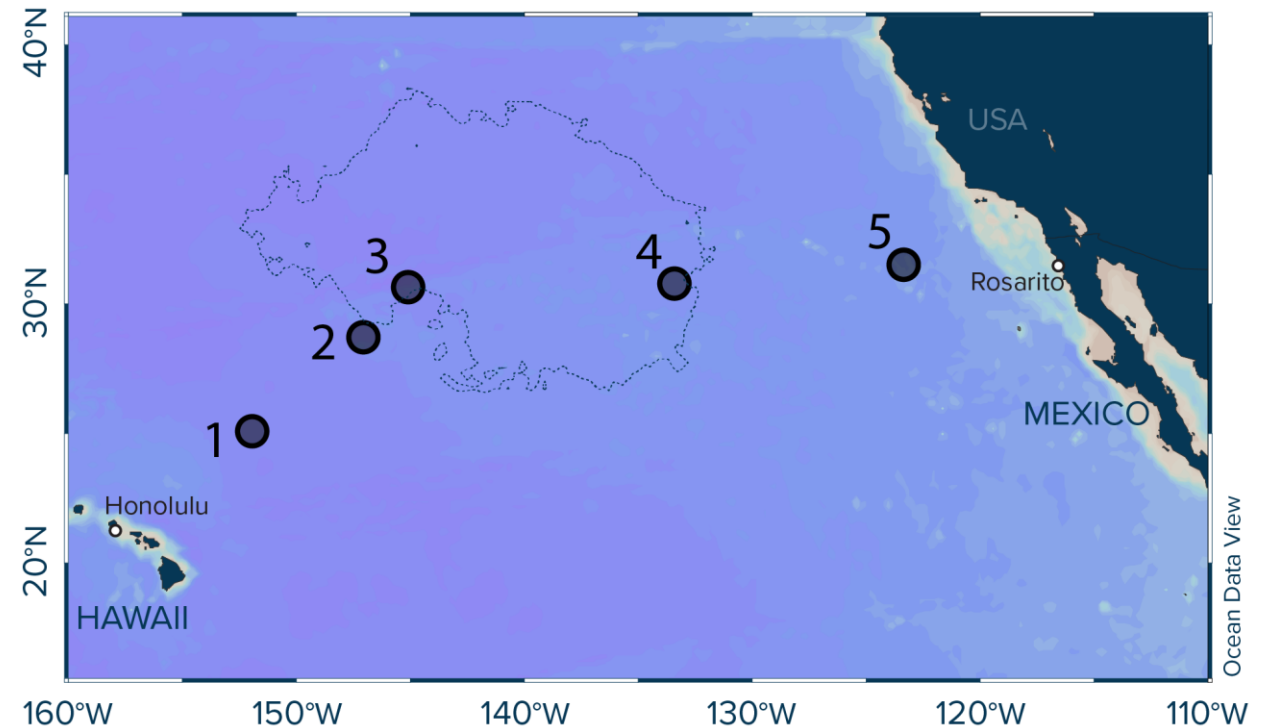
# Sampling

## Cruise transect

Vertical concentration profiles (0-2000 m water depth) of plastic debris >500  $\mu\text{m}$  were collected at five locations onboard the Maersk Transporter in November-December 2018.

## Methods

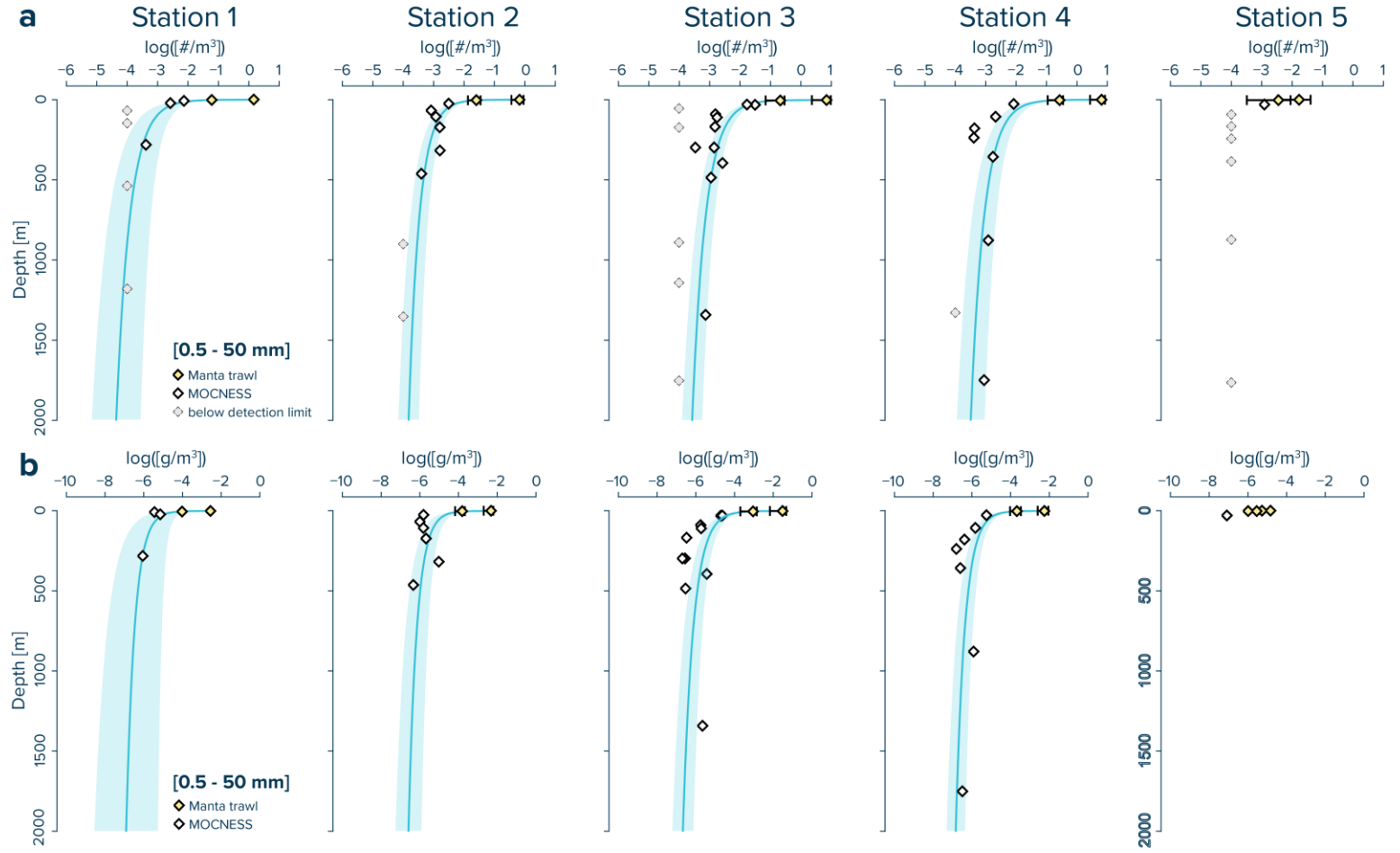
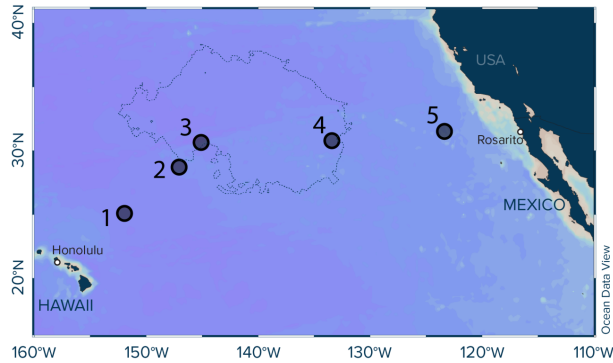
- Sea surface:
  - Manta trawling
- Water column:
  - CTD profiling (temperature, salinity,  $\text{O}_2$ , fluorescence)
  - Underwater trawling with **MOCNESS** (Multiple Opening and Closing Net with an Environmental Sensing System)



# Results

## Water column profiles

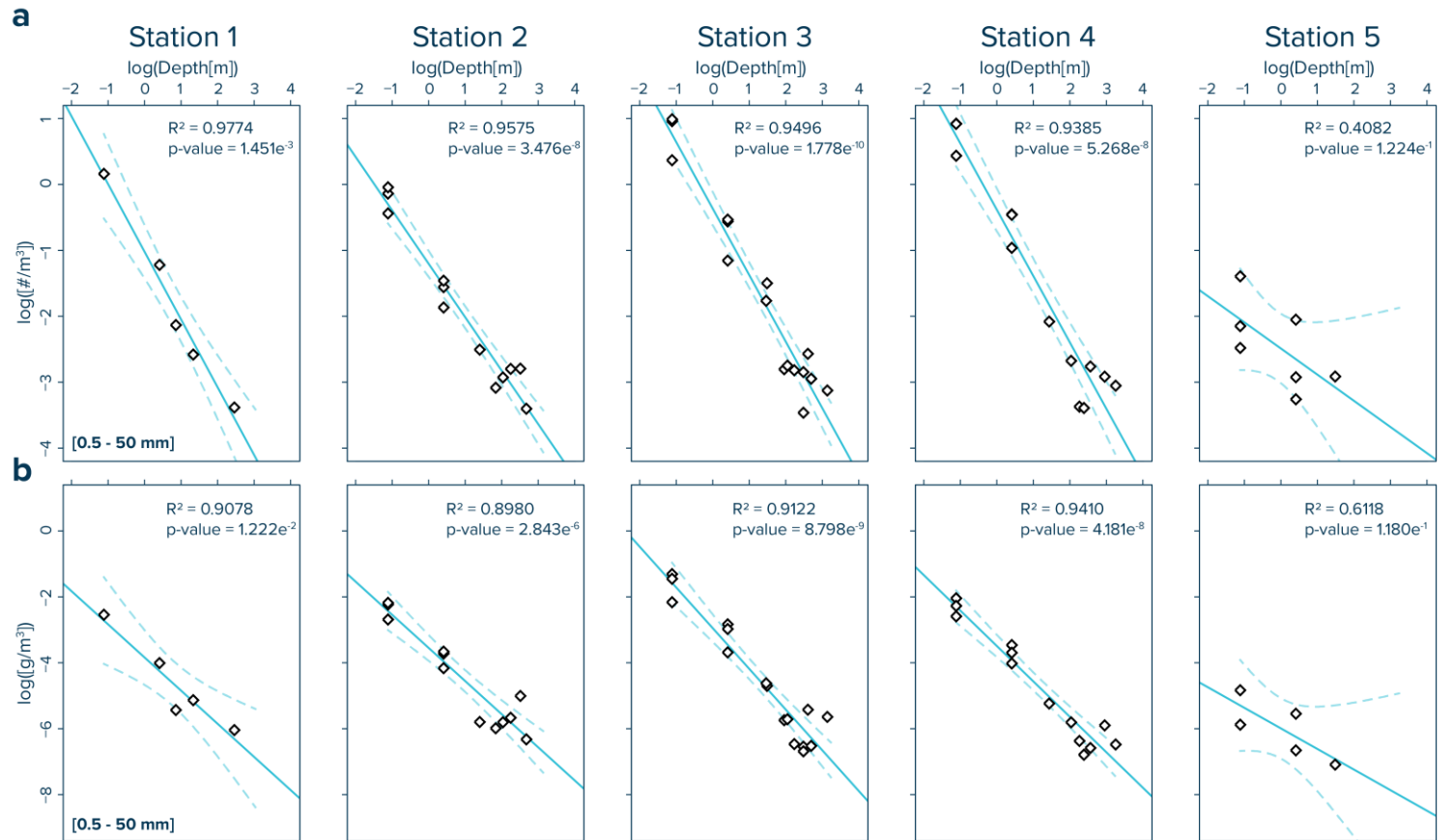
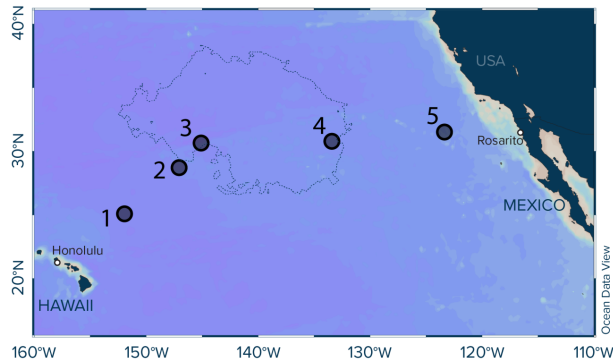
- Detection limit:  $\sim 10^{-4} \text{ \#/m}^3$
- Blue lines: Modelled profiles based on log-log correlations (next slide)



# Results

## Power law functions to model water column plastic concentrations

- Log-log plots of water depth vs. (a) numerical and (b) mass concentrations of plastic fragments
- Dashed line: 95% confidence interval of linear regression



# Results

## Polymer composition

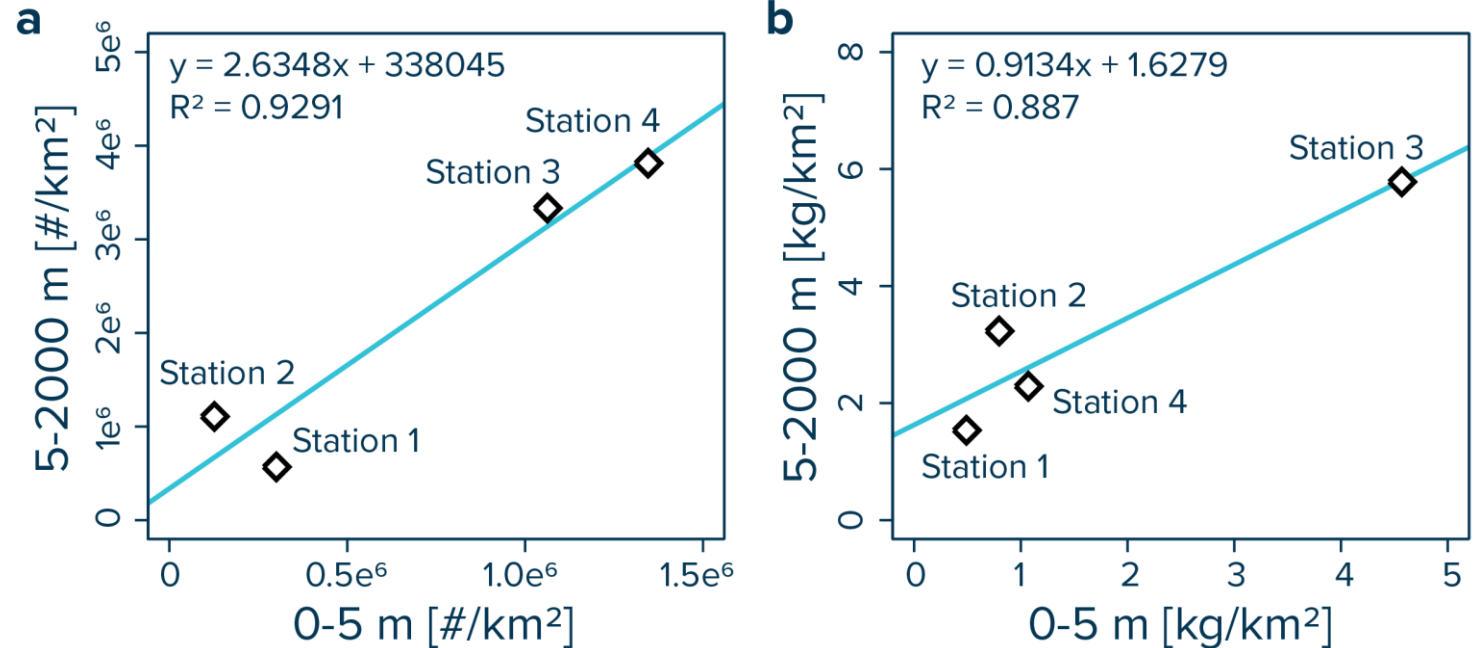
- Based on Raman and FTIR spectroscopy
- PE & PP are the dominant polymers at the sea surface as well as in the water column

	# fragments	PE	PP	PVC	PS	unknown
Manta 1	53	92%	8%	-	-	-
Manta 2	27	96%	4%	-	-	-
Manta 3	31	94%	6%	-	-	-
Manta 4	32	91%	9%	-	-	-
Manta 5	7	100%	-	-	-	-
MOCNESS 1	3	33%	33%	-	-	33%
MOCNESS 2	20	65%	25%	5%	5%	-
MOCNESS 3	90	83%	10%	-	1%	6%
MOCNESS 4	39	97%	-	-	3%	-
MOCNESS 5	3	67%	-	-	33%	-

# Results

## Depth-integrated concentrations of micro- and mesoplastic debris

- 0-5 m: Manta trawl data corrected for wind-induced mixing (*Kukulka et al., 2012*)
- 5-2000 m: Integrated power-law functions (see slide 4), 1 m vertical resolution



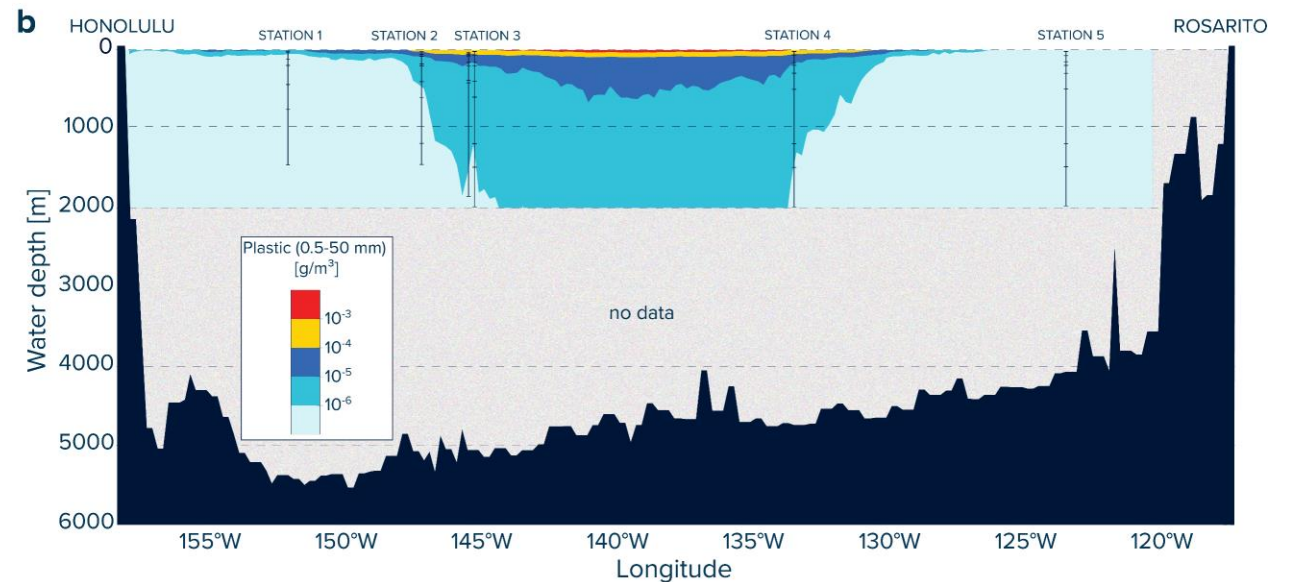
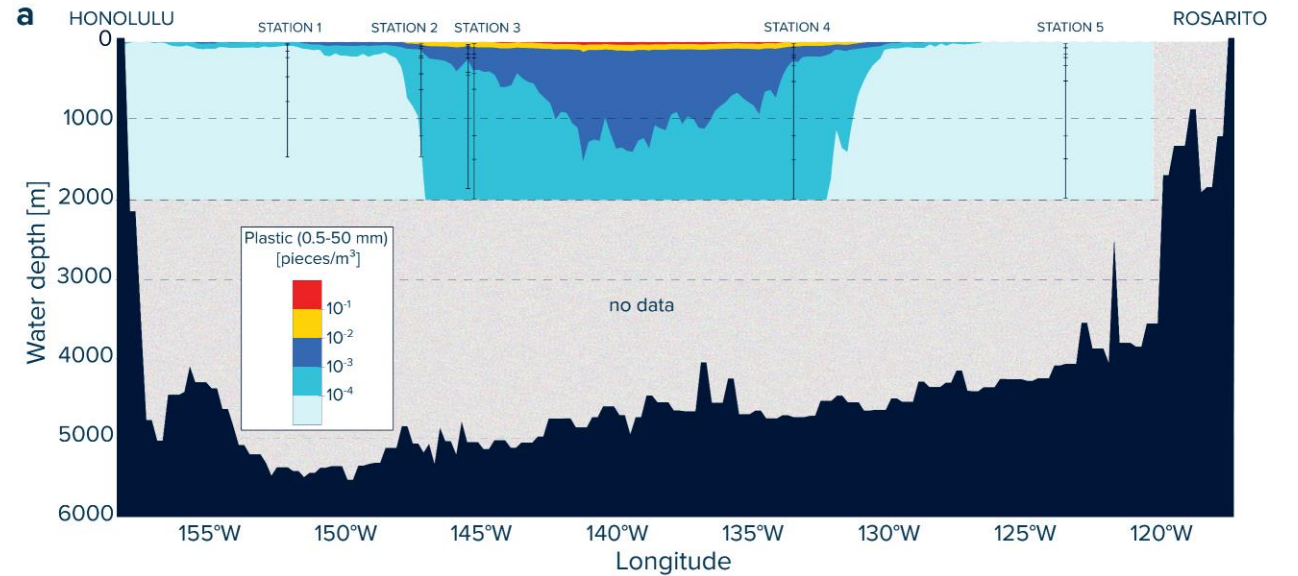
- Note: Microplastics (0.5-5mm) and mesoplastics (5mm-5cm) account for an estimated ~20% of the total plastic mass loading in the GPGP, with the other 80% attributed to plastic objects > 5cm in size (*Lebreton et al., 2018*).



# Results

## Predicted vertical distribution

- Water column concentrations were estimated as a function of the debris afloat at the ocean surface and corresponding water depth.
- No information on spatio-temporal variability -> At best, a snapshot of the vertical distribution in late 2018. **Large uncertainties remain!**





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# Discussion

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## Main findings

- The presence of plastics in the water column below the Great Pacific Garbage Patch (GPGP) is the result of microplastic (< 5 mm) fallout from its surface waters.
- Plastic particles in the water column are mostly in the size range of particles missing in reported surface trawls (Cózar et al., 2014; Eriksen et al., 2014).
- First results indicate that about 90% of the plastic mass in the upper 2000 m of the water column in the GPGP could be concentrated in the top 5 m.
- If not intervened, plastic fallout will likely increase contamination of the deep sea below ocean garbage patches, where cleanup is even more difficult, if not impossible.

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## Take-home message

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Part of the plastic debris afloat in the Great Pacific Garbage Patch is lost to the underlying deep sea through fallout of small and once-buoyant plastic fragments.

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## Next steps

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### Future research

- Quantify vertical plastic flux (numerical models, sediment trap installations)
- Determine microplastic sedimentation mechanisms and their relative importance
- Evaluate spatio-temporal variability of water column concentrations



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# Acknowledgements

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## Funding

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## Sampling

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## Analysis

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- Erik Zettler (NIOZ)
- Mark de Boer (Zoo of Rotterdam)