Global Distribution of Microplastics: An Overview

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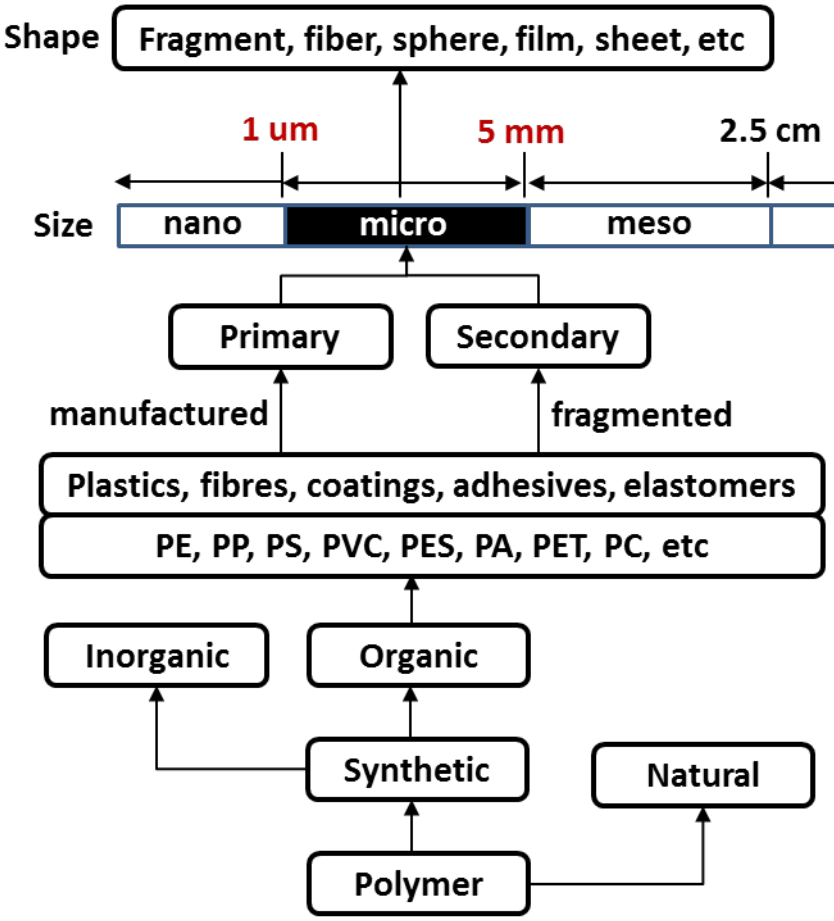
Microplastics

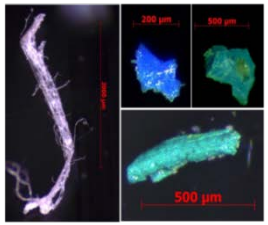


Primary microplastics

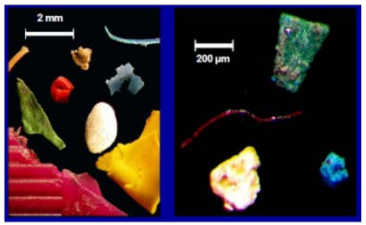
Resin pellets (Geoje, Korea/ KIOST)

PE microbeads in cosmetics

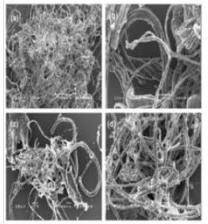
Secondary microplastics



Sand beach (Geoje/KIOST)



Sewage sludge (Zubris & Richards, 2005)



Lobster(Murray & Cowie, 2011)

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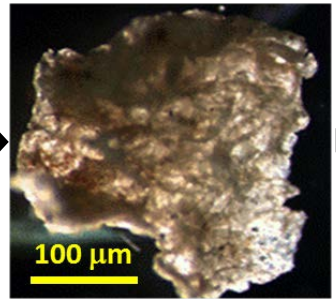
Paradigm shift

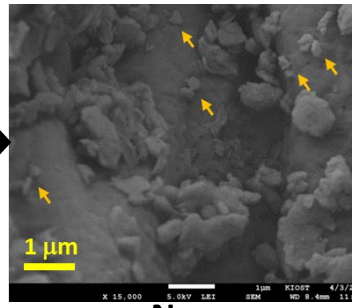

Mega


Macro

Meso



Micro



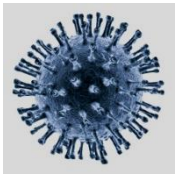
Nano


Hippo


Dog


Ant


Dust mite


Virus

Increasing …

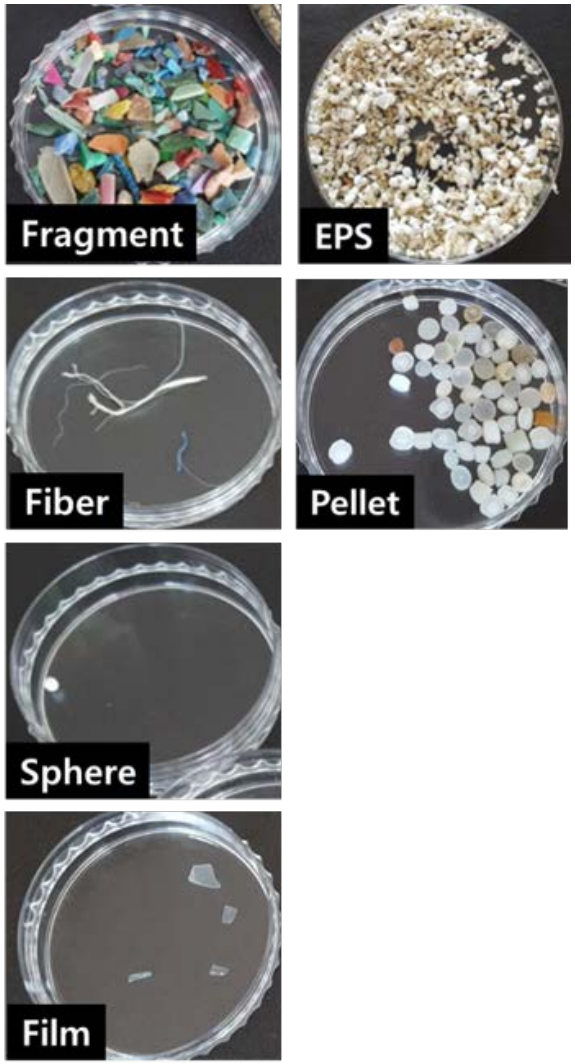
- Numbers
- Bioavailability
- Target organisms
- Toxicity
- Detection difficulty
- Cleanup difficulty

Decreasing …

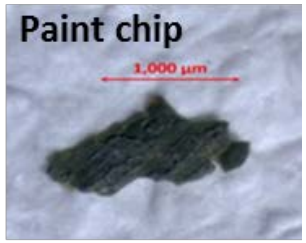
- Volume
- Entanglement
- Settling velocity

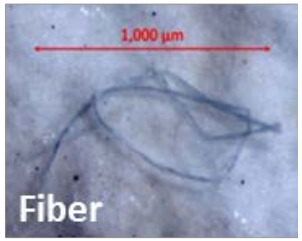
Microplastics

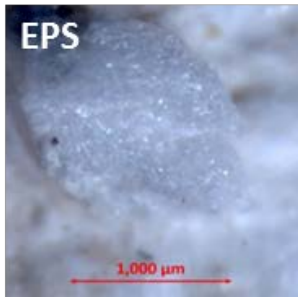
Large MP (1-5 mm) and Mesoplastics (5-25 mm)



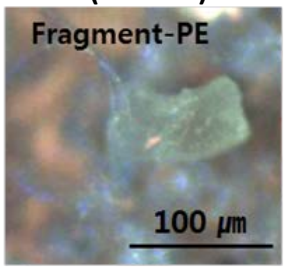
Large MP (1-5 mm)

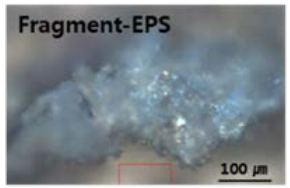


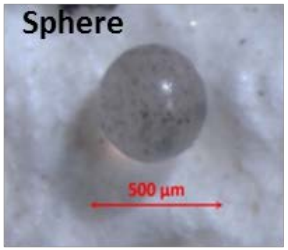


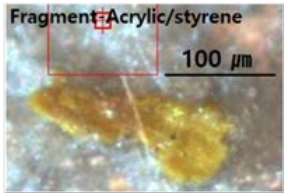


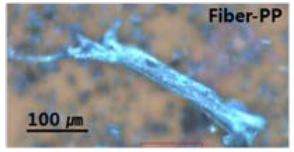
Small MP (< 1 mm)











Ubiquitous from coast to Arctic

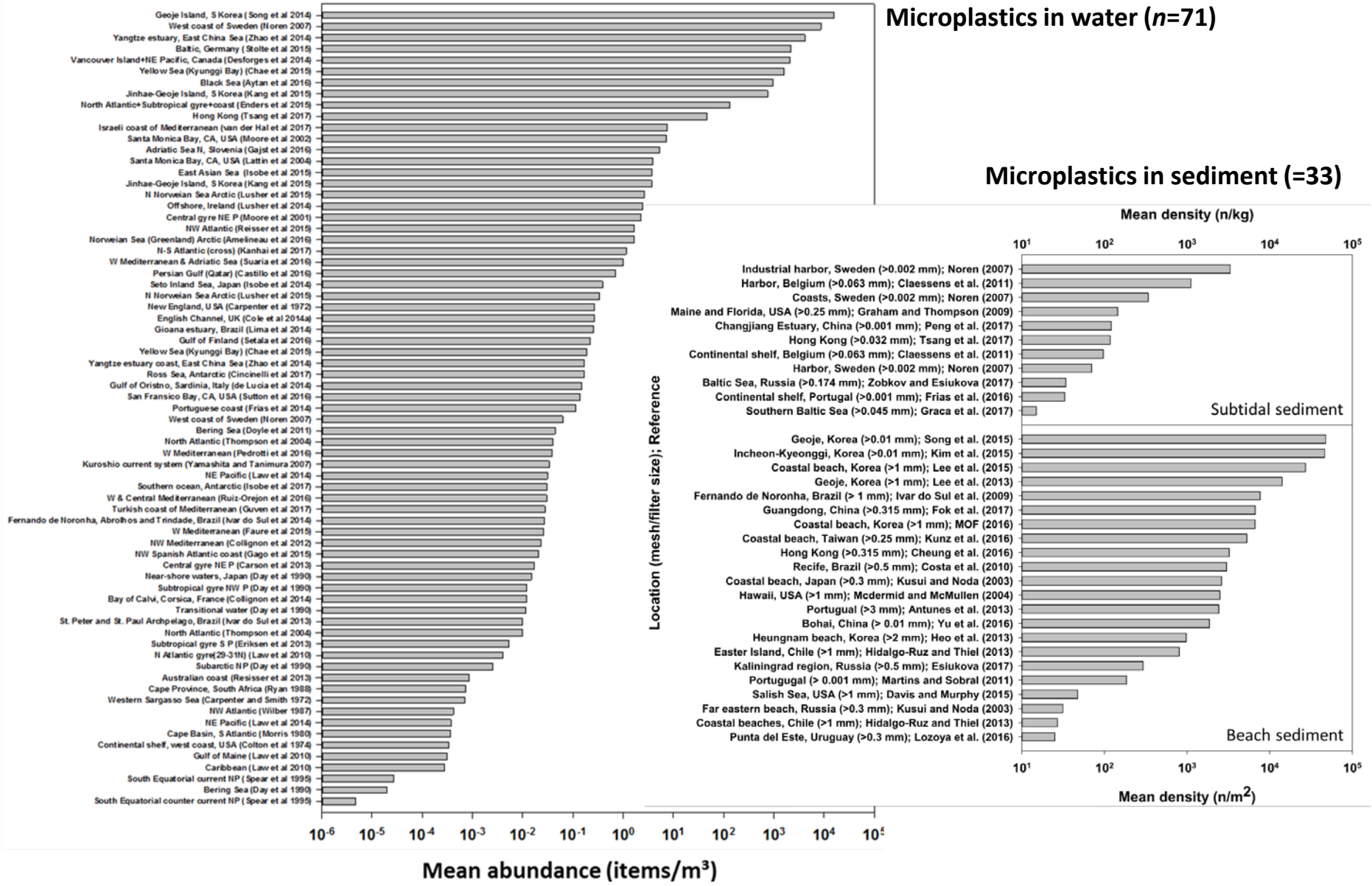
- **Marine environments**
  - Coastal sediment and water
  - Water column
  - Deep sea floor
  - Arctic ice core
  - Organisms (from zooplankton to mammals)

- **Terrestrial/Freshwater environments**
  - River water and sediment
  - Lake and sediment
  - Soil
  - Sewage and wastewater treatment plant

- **Atmospheric environments**
  - Indoor and outdoor air

- **Food**
  - Oyster, mussel, anchovy, table salts, beer and honey

Abundance of microplastics reported in the marine environments



Shim et al. (2017) *Microplastics in Marine Environments: Abundance, Composition and Distribution.*
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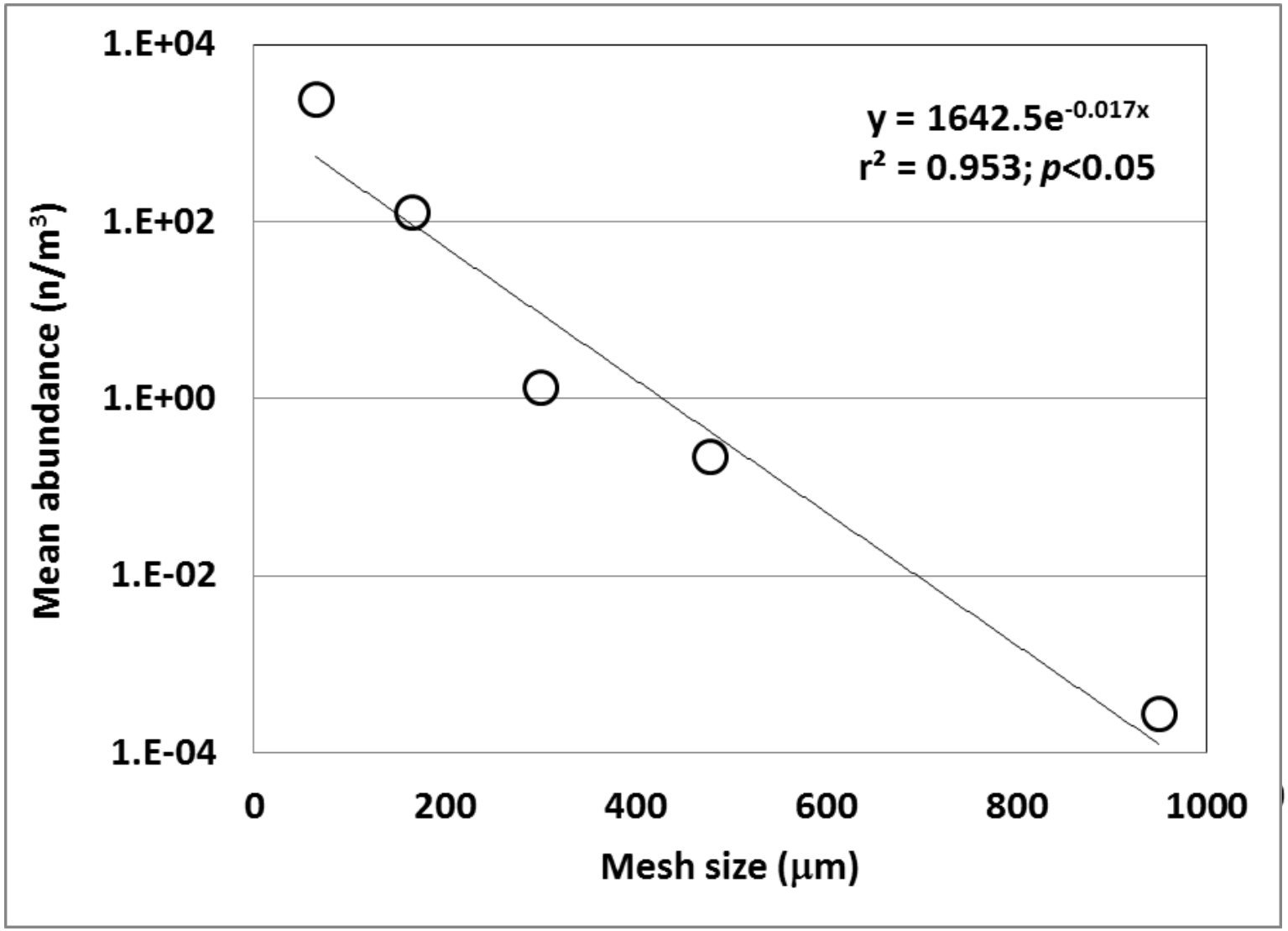
Microplastic abundances reported in water by net mesh size



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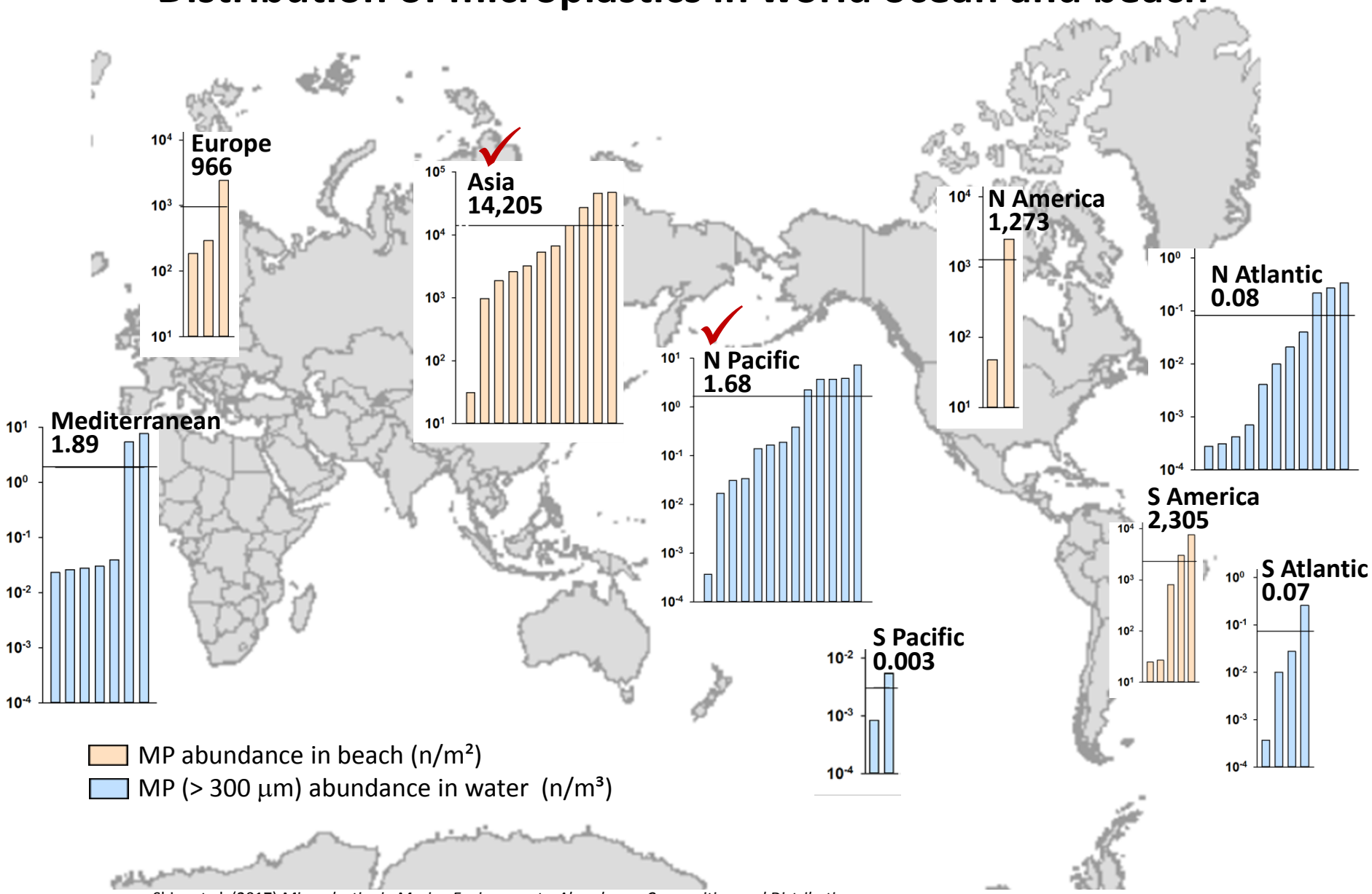
Distribution of microplastics in world ocean and beach



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Distribution of microplastic in world ocean

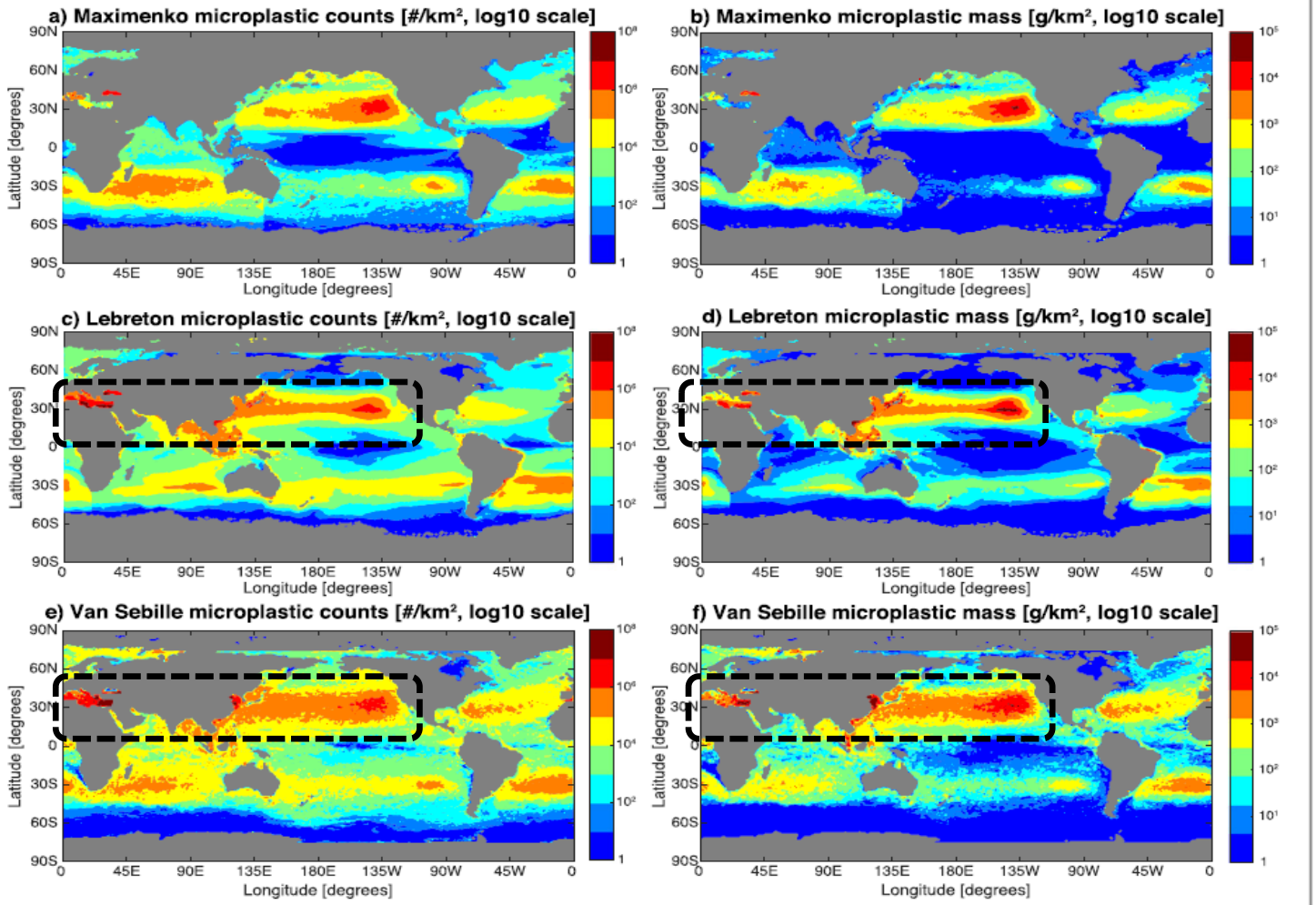
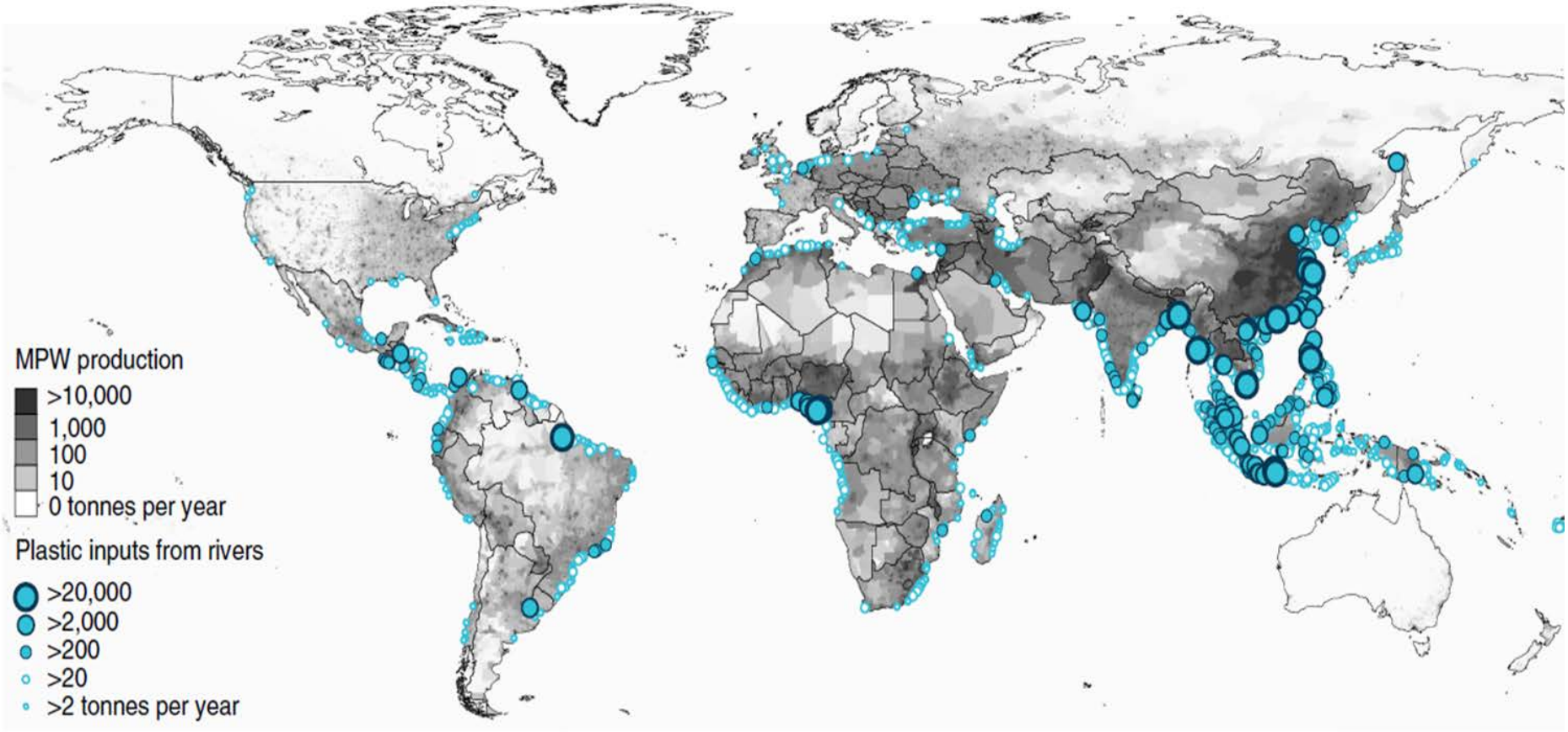


Figure 3. Maps of the solutions of microplastic count (left column) and mass (right column) distribution for the three different models. Because fits are done on a per-basin level, there are a few discontinuities visible (e.g. South of Tasmania in the Maximenko solution, panel (a).

Van Sebille et al. (2015) *Environ Res Lett*

Mass of river plastic flowing into oceans in tons per year



Lebreton et al. (2017) *Nat Comm* 8:15611

Top 20 polluting rivers as predicted by the global river plastic inputs model

Top 20 polluting rivers as predicted by the global river plastic inputs model.

Catchment	Country	Lower mass input estimate ($t\,yr^{-1}$)	Midpoint mass input estimate ($t\,yr^{-1}$)	Upper mass input estimate ($t\,yr^{-1}$)	Total catchment surface area (km^2)[21]	Yearly average discharge ($m^3\,s^{-1}$)[21]
Yangtze	China	3.10×10^5	3.33×10^5	4.80×10^5	1.91×10^6	1.58×10^4
Ganges	India, Bangladesh	1.05×10^5	1.15×10^5	1.72×10^5	1.57×10^6	2.08×10^4
Xi	China	6.46×10^4	7.39×10^4	1.14×10^5	3.89×10^5	5.53×10^3
Huangpu	China	3.35×10^4	4.08×10^4	6.73×10^4	2.62×10^4	4.04×10^2
Cross	Nigeria, Cameroon	3.38×10^4	4.03×10^4	6.5×10^4	2.38×10^3	2.40×10^2
Brantas	Indonesia	3.23×10^4	3.89×10^4	6.37×10^4	1.11×10^4	8.18×10^2
Amazon	Brazil, Peru, Columbia, Ecuador	3.22×10^4	3.89×10^4	6.38×10^4	5.91×10^6	1.40×10^5
Pasig	Philippines	3.21×10^4	3.88×10^4	6.37×10^4	4.07×10^3	2.07×10^2
Irrawaddy	Myanmar	2.97×10^4	3.53×10^4	5.69×10^4	3.77×10^5	5.49×10^3
Solo	Indonesia	2.65×10^4	3.25×10^4	5.41×10^4	1.58×10^4	7.46×10^2
Mekong	Thailand, Cambodia, Laos, China, Myanmar, Vietnam	1.88×10^4	2.28×10^4	3.76×10^4	7.74×10^5	6.01×10^3
Imo	Nigeria	1.75×10^4	2.15×10^4	3.61×10^4	7.92×10^3	2.79×10^2
Dong	China	1.57×10^4	1.91×10^4	3.17×10^4	3.33×10^4	8.54×10^2
Serayu	Indonesia	1.33×10^4	1.71×10^4	2.99×10^4	3.71×10^3	3.70×10^2
Magdalena	Colombia	1.29×10^4	1.67×10^4	2.95×10^4	2.61×10^5	5.93×10^3
Tamsui	Taiwan	1.16×10^4	1.47×10^4	2.54×10^4	2.68×10^3	1.08×10^2
Zhujiang	China	1.09×10^4	1.36×10^4	2.31×10^4	4.01×10^3	1.33×10^2
Hanjiang	China	1.03×10^4	1.29×10^4	2.19×10^4	2.95×10^4	7.35×10^2
Progo	Indonesia	9.80×10^4	1.28×10^4	2.29×10^4	2.24×10^3	2.79×10^2
Kwa Ibo	Nigeria	9.29×10^4	1.19×10^4	2.08×10^4	3.63×10^3	1.92×10^2

Input rate estimates (in $t\,yr^{-1}$) are representative of mismanaged plastic waste (MPW) production and catchment runoff. A lower, midpoint and upper estimate is calculated based on three regression analyses accounting for uncertainties in our field observations data set.

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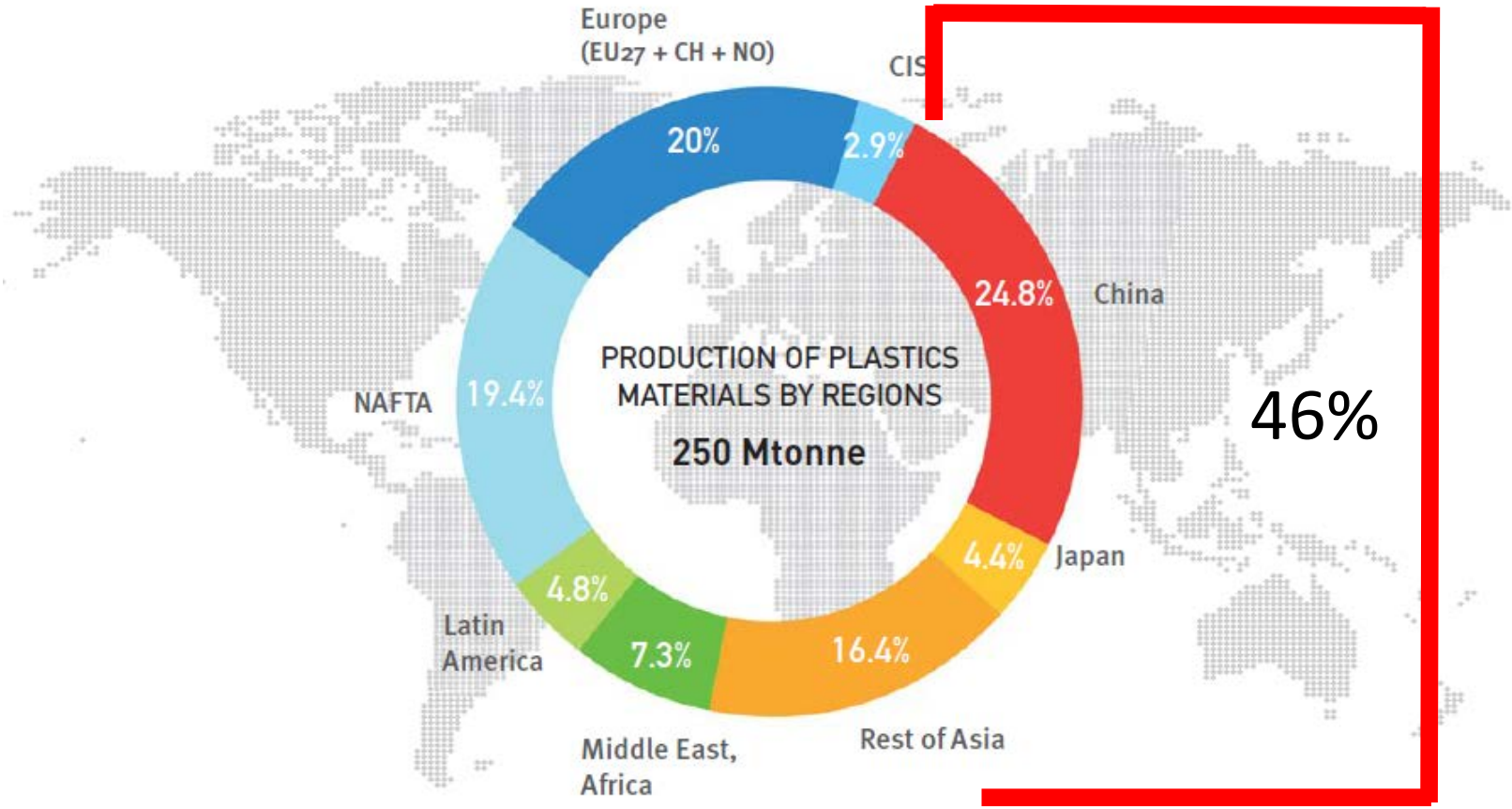
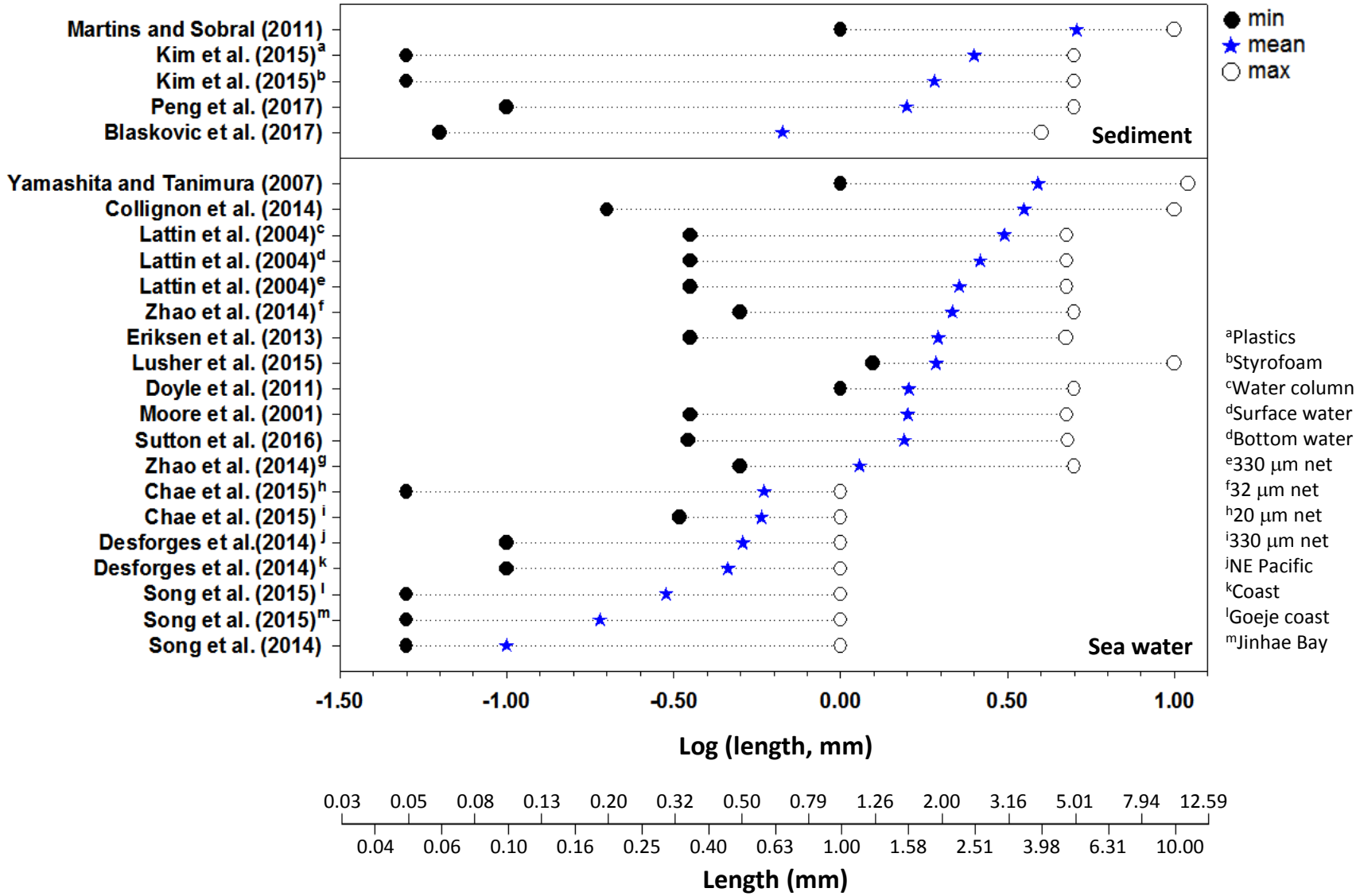
Global Plastic production

Source: PlasticsEurope Market Research Group (PEMRG, 2014)



2013 World production of plastics materials (thermoplastics and polyurethanes)
Does not include other plastics (thermosets, adhesives, coatings and sealants) nor PP-fibers.
Source: PlasticsEurope (PEMRG) / Consultic

Size distribution of microplastic in sea water and sediments



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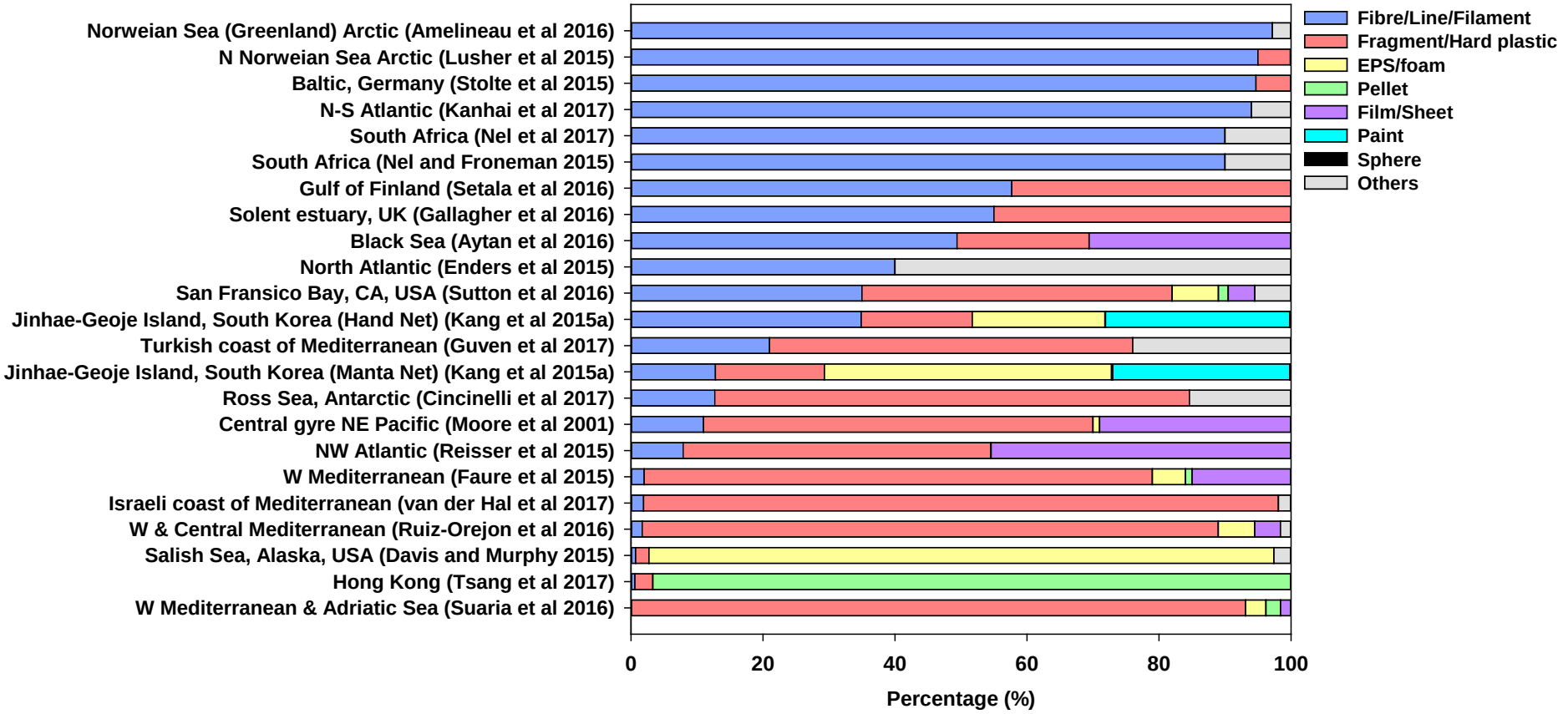
Shape composition of microplastics in sea water



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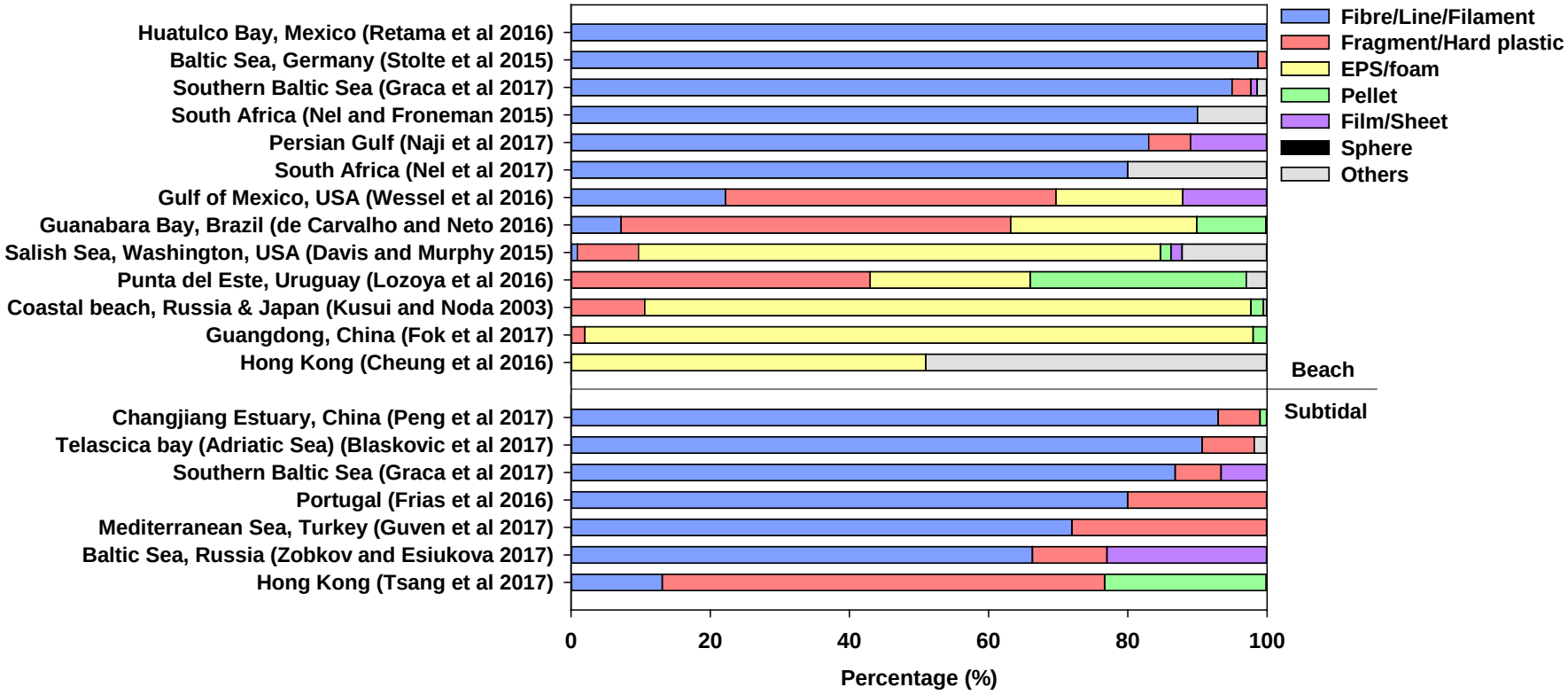
Shape composition of microplastics in sediment



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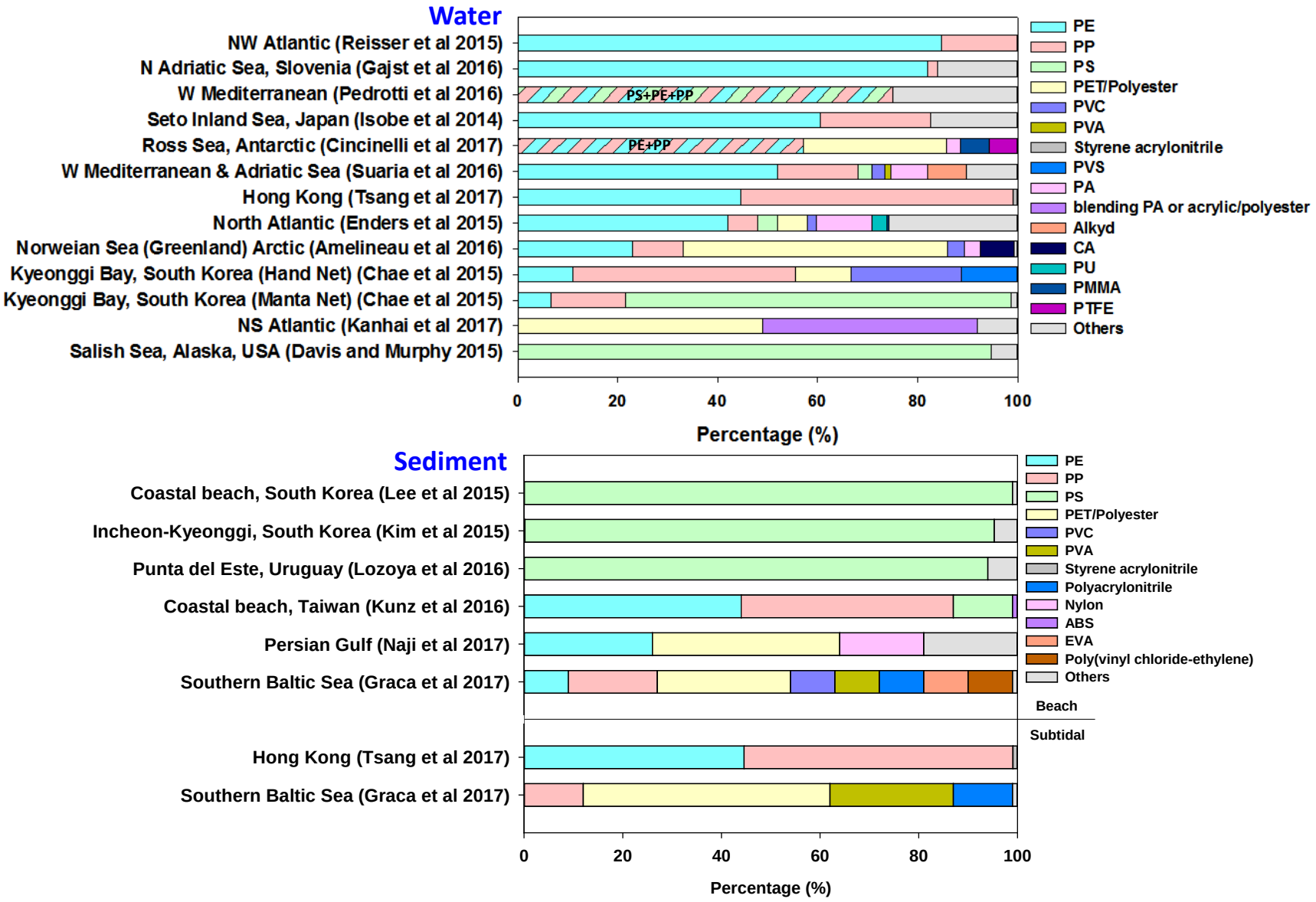
Polymer composition of microplastic in sea water and sediments



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Conclusion

- World plastic production, *in situ* observation and river input and transportation models indicated Asia and North Pacific as hotspot of MP pollution.
- MP abundance in water showed significant correlation with the net mesh size for sampling.
- The peak size distribution of MP reflected the size range of the sampling and analytical methods.
- The dominant MP shape was fibre or fragment for water, fibre or foam for beach and fibre for subtidal sediment.
- PE, PP and PS were top ranked polymer types with some exceptions.

Thank you!

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