The Arctic Deep Sea - A Sink for Microplastic?

Melanie Bergmann
Wirzberger, Krumpen, Lorenz, Primpke, Tekman, Gerdts
Where it all started…

Strong increase in litter quantities on deep Arctic seafloor between 2002 – 2014

(Source: T. Soltwedel)

(Bergmann & Klages 2012, Tekman et al. 2017)
Where it all started...

Sea surface
$\varnothing = 27$ items km$^{-2}$

Deep seafloor
$\varnothing = 8,081$ items km$^{-2}$

Deep seafloor is a sink for marine litter

(Bergmann & Klages 2012, Tekman et al. 2017)
**Aim:** Sample litter and microplastic from the cryosphere to the seafloor to identify sinks and pathways

- **Sebastian Primpke**
  - Monday, 16:30
  - St. Tropez
  - Water column: particle traps, pumps

- **Mine Tekman**
  - Thursday, 11:15
  - St. Tropez
  - Sea surface: observer, UAV, neuston nets

- **Melanie Bergmann**
  - Monday, 14:45
  - Riviera
  - Ice cores & snow
  - Seafloor: multiple corer, OFOS
  - Beach: citizen clean ups
4 stations along latitudinal gradient (marginal ice zone, Atlantic)
6 stations along bathymetric gradient (2,500 – 5,500 m)
➢ Assess the influence of depth and ice on microplastic abundance
Analytical approach

- Separation of sediment and MP by MicroPlastic Sediment Separator with ZnCl₂
- Filtration into two size fractions:
  - >500 µm: visual pre-selection and analysis by ATR-FTIR
  - < 500 µm: pre-treatment with Fenton’s reagent (FeSO₄ + H₂O₂), filtration onto aluminium oxide filter and analysis by μ-FTIR/chemical imaging

(Source: Gerdts et al.)
Results: Microplastic quantities

- Highest MP abundance to date: 42–6,595 MPs kg\(^{-1}\)
- Many black particles: coal
- Highest quantities in the North (marginal ice zone)

(Bergmann et al. 2017, Env Sci Technol)
Results: Polymer composition

- 18 different polymer types, 5-14 polymers per sample
- >500 µm: polytetrafluoroethylene
- Only 10% similarity in composition from deep station (PP, nitrile rubber)
- Overall 60 - 80% similarity in polymer composition
- Chlorinated polyethylene: 38% > polyamide 22% > 16% PP > 8% nitrile rubber

(Bergmann et al. 2017, Env Sci Technol)
Results: Microplastic sizes

78% ≤ 25 μm

No cut-off point: large dark figure in small size range?

(Bergmann et al. 2017, Env Sci Technol)
Correlation with environmental factors

- No correlation with depth
- No correlation with ice coverage above stations

(Source: J. Hagemann)
Correlation with environmental factors

- No correlation with depth
- No correlation with ice coverage above stations
- Positive correlation between chlorophyll a and MP abundance and diversity: enhanced sinking via incorporation into (ice-) algal aggregates?
- Freezing cycles → increased fragmentation ? → smaller MPs sink faster (higher surface/volume)
A sink?

Sea surface (pump)  
\[ \varnothing = 0.51 \text{ MPs L}^{-1} \]

(Tekman et al., in preparation)

\[ \times 4400 \]

Deep-sea sediments are a sink for microplastic

Deep-sea sediments *  
\[ \varnothing = 2264 \text{ MPs L}^{-1} \]

*data converted to MPs L\(^{-1}\)
Possible sources and pathways

- Build up of plastic debris from distant Atlantic sources
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- Leakage from Arctic rivers and the Pacific?
- Atmospheric transport and deposition?

(From: Outridge et al. 2008)
Summary

- Highest seafloor quantities measured to date (as MP kg\(^{-1}\))
- Large proportion of small microplastics
- As a final sink for microplastic the deep sea may be the most suitable end point for long-term monitoring
Vast blind areas: Need to increase our benthic knowledge base!
Thanks!

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