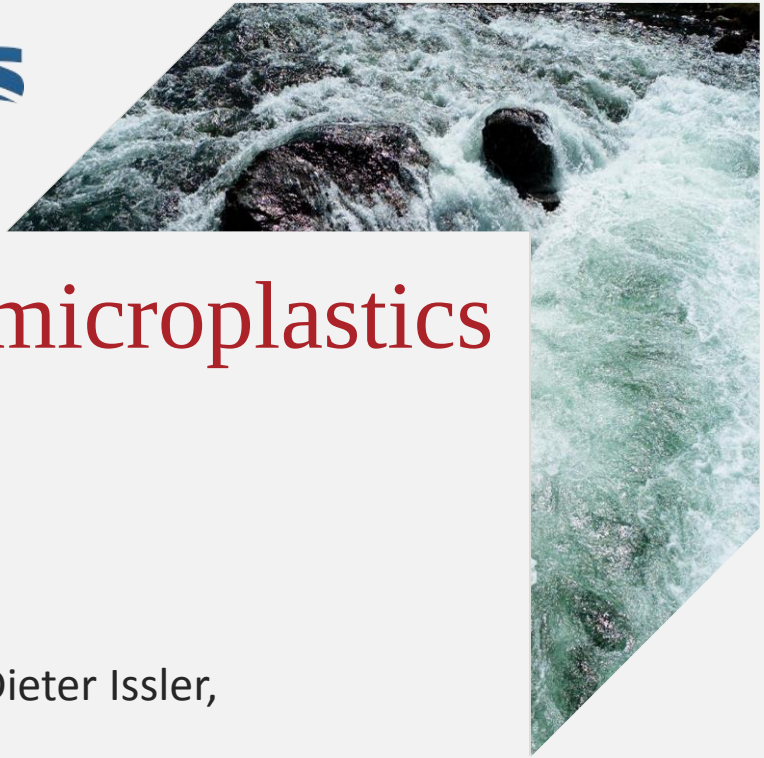


The sinking behavior of microplastics

The influence of weathering on MP aggregation and settling

Linn Merethe Brekke Olsen, Naiara Berrojalbiz, Dieter Issler, Hans Peter Arp

Miljøringen, 16/03-17

Microplastic; an increasing environmental problem

NRK Nyheter Sport TV Radio Distrikt Søk

Hordaland Nettserien «Mottaket» Vestlandsrevyen P1 Hordaland Tips 03030

Fann 30 plastposar i magen på den sjeldne kvalen

Gåsenebbkvalen var aldri dokumentert i Noreg før han blei avliva. I magesekken fann forskarane 30 plastposar og store mengder småplast.

PROPPFULL: Over 30 plastposar og store mengder mikroplast blei henta ut av magesekken til den sjuke og avliva gåsenebbkvalen.
FOTO: CHRISTOPH NOEVER / UNIVERSITETET I BERGEN

Det var reint tilfeldig at zoologar ved Universitetet i Bergen blei gjort merksame på kvalen som stranda på Sotra utanfor Bergen i helga.

Det ein lenge trudde var ein grindkval hadde gått seg fast tre gongar før viltnemnda tok livet av kvalen, som bar preg av å vera sjuk.

Mikroplast

> Mikroplast er små plastpartikler i miljøet som er på størrelse fra 5 millimeter ned til 1um.

Bergens Tidende
8. februar

Visste du at klærne våre er en av de største kildene til forurensning i havet?

Hver gang vi vasker syntetiske klær, havner mikroplast i havet

- Klesprodusentene er flinke til å lure oss.

BT.NO

Microplastic; an increasing environmental problem

- Fieldwork Frierstranden, June 2016

Microplastic; an increasing environmental problem

- 275 million tons of plastic was generated during 2010
- Over 4.8 million tons entered the ocean
- In 2025, it is estimated to increase with one order of magnitude
- **Where does it go?**
- Weathering degrades the plastic into smaller pieces
- **How does weathering affect the sinking behavior?**

Jambeck et al., *Science* 2015

- Joint Programming Initiative Healthy and Productive Seas **(JPI OCEANS):** Strategic platform established in 2011, focusing on marine and maritime research.
- **WEATHER-MIC:** How microplastic weathering changes its transport, fate and toxicity in the marine environment
- Norwegian Geotechnical Institute **(NGI):** Leading two workpackages and co-leading in collaboration with:

HELMHOLTZ CENTRE FOR ENVIRONMENTAL RESEARCH – UFZ

KU LEUVEN

Stockholm University

Fraunhofer IKTS

Objectives

How microplastic weathering changes its transport, fate and toxicity in the marine environment

- Gravitational settling and modeling of the sinking behaviour
- Field samples
- Separation and digestion methods

Materials: Microplastics and microfibers

Reference size spheres/powders:

Standarized cospheric polystyrene **(PS)** spheres

Standarized cospheric polyethylene **(PE)** powder

Density ca. 1.05 kg/L

Microplastic granules, powders and fibers

Polyethylene terephthalate **(PET)** (1.4 kg/L)

PS (1.05 kg/L)

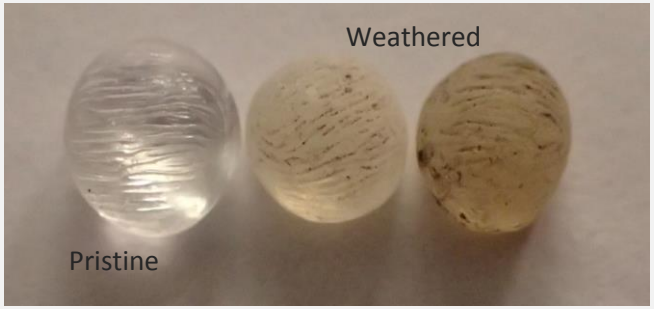
Weathered particles

UV aged

Outside weathering: Exposure to UV-light, rain, snow, ice etc.

Materials: Weathered microplastics

- UV aging (IKTS, Stockholm University, NGI)



Polystyrene particles (PS) collected from NGI roof feb.2017 after 10 months

- Colour differences
- Density difference?
- Change in brittleness?
- Change in surface properties?

Methods: Column experiments for settling rate

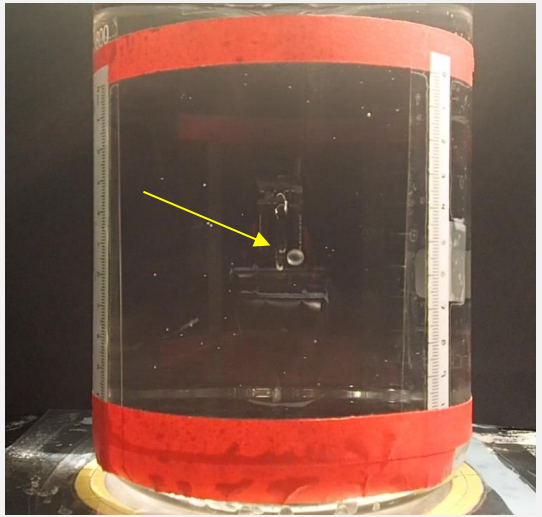
- Laboratory:

Film-processing of **single particles** settling in a column (30 or 60 fps)

f (particle density, shape, size)

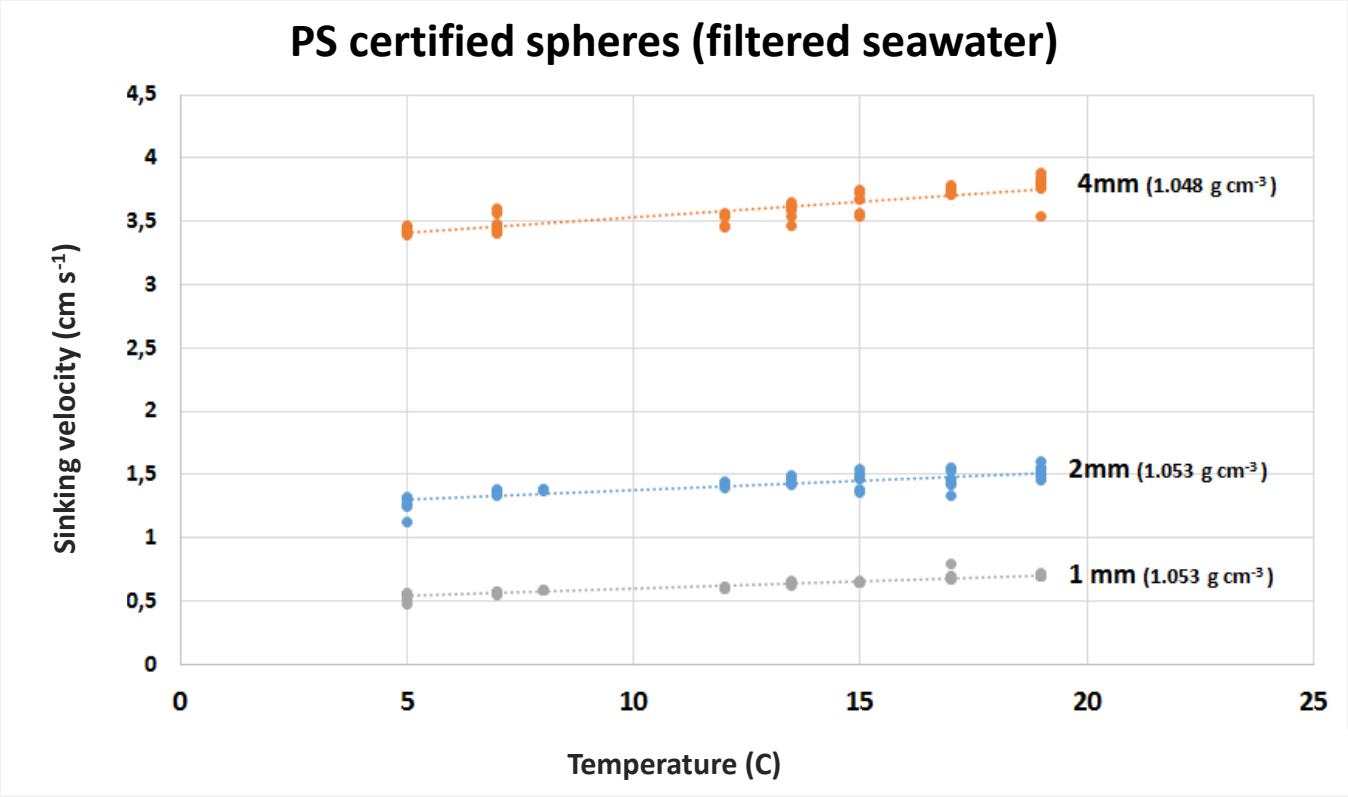
f (fluid density, turbidity, particulates, turbulence)

f (effect of weathering)



10 cm beaker

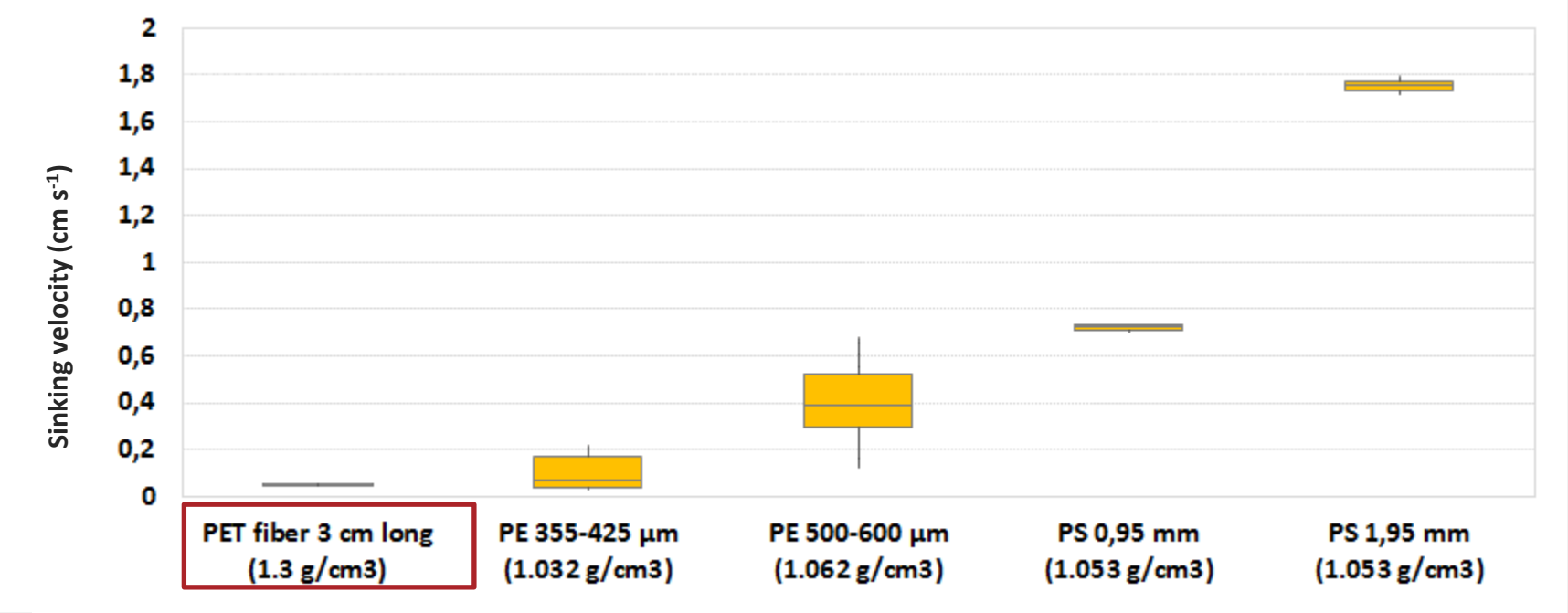
Results: Effect of particle size and temp/density



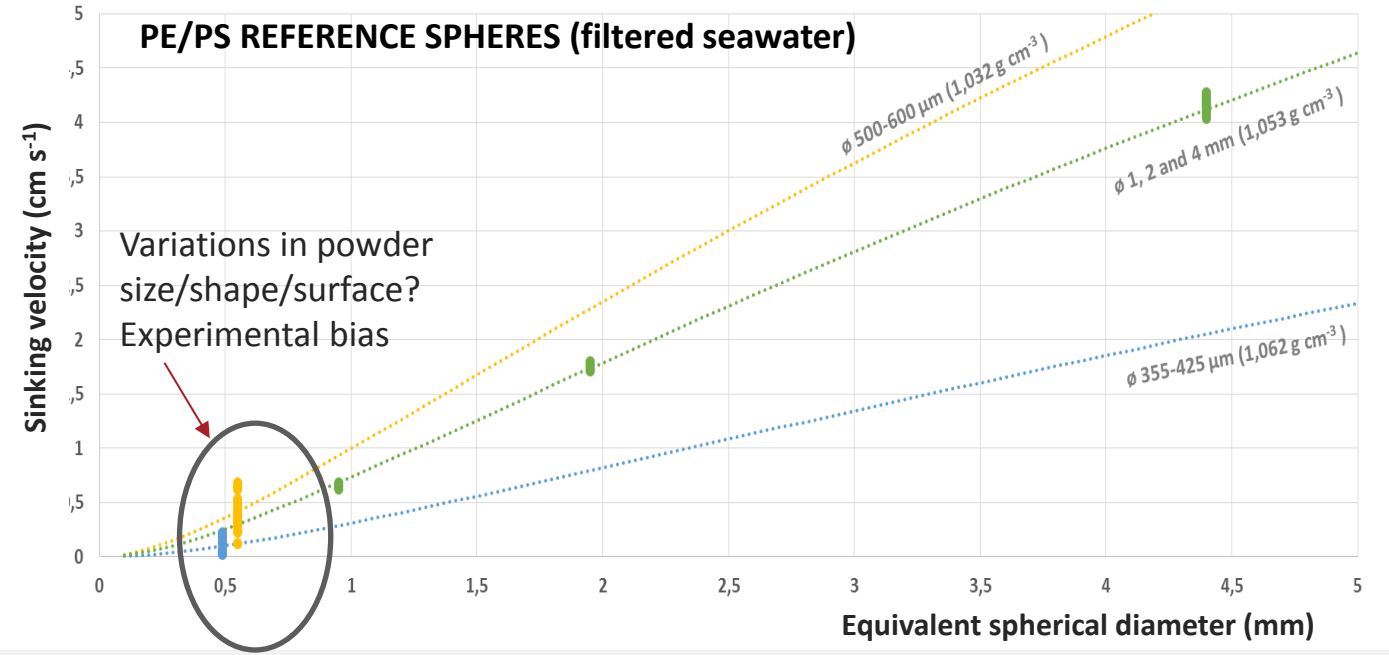
Linear regression

Results: Effect of particle size/density

Filtered seawater



Results: Effect of particle size/density

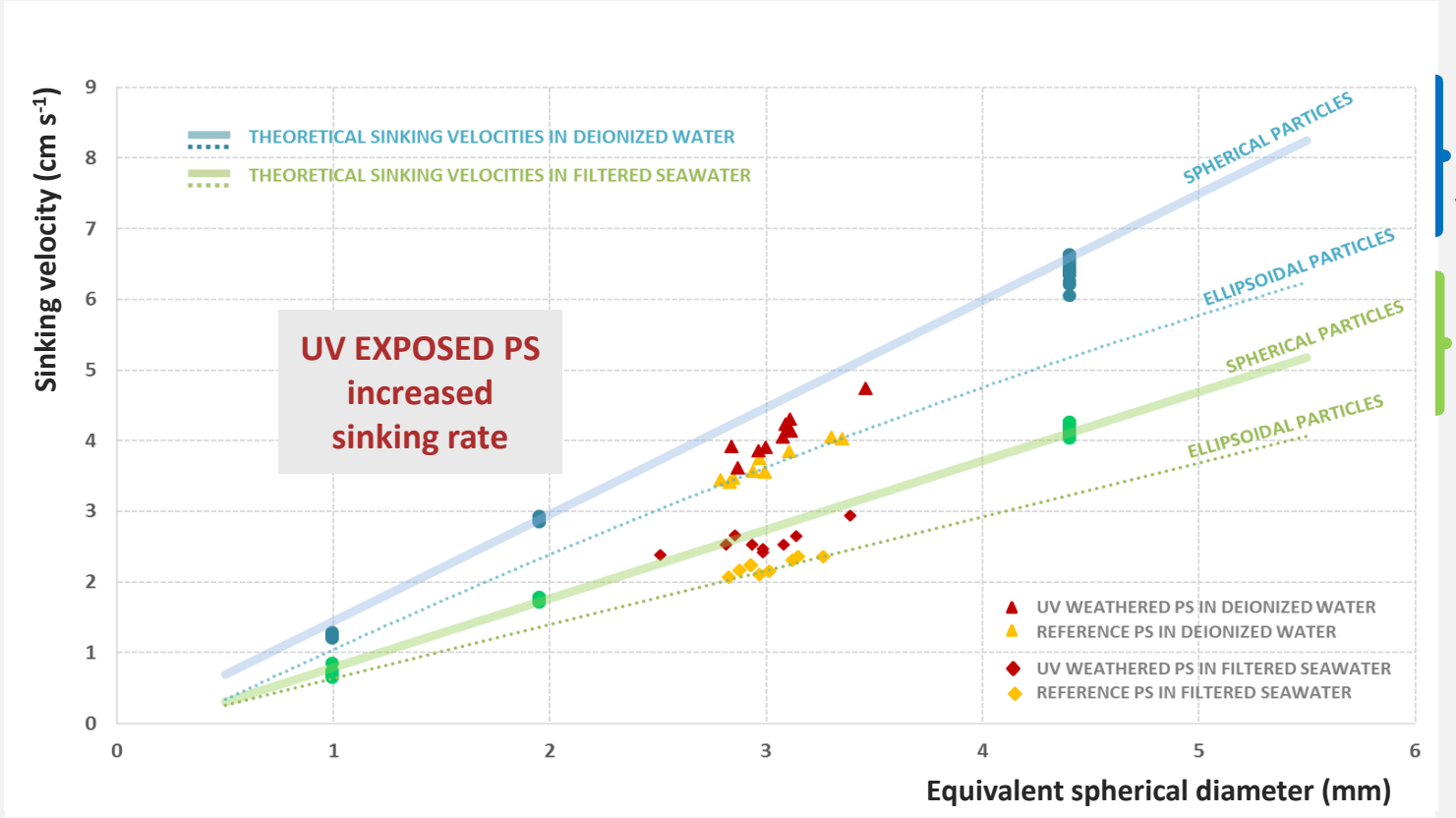


Empirical model Dietrich W.E. (1982)

- Particle size
- Particle density
- Density of the fluid

Model gives good average fit for perfect spheres, but limits to emperical predictions for small reference spheres

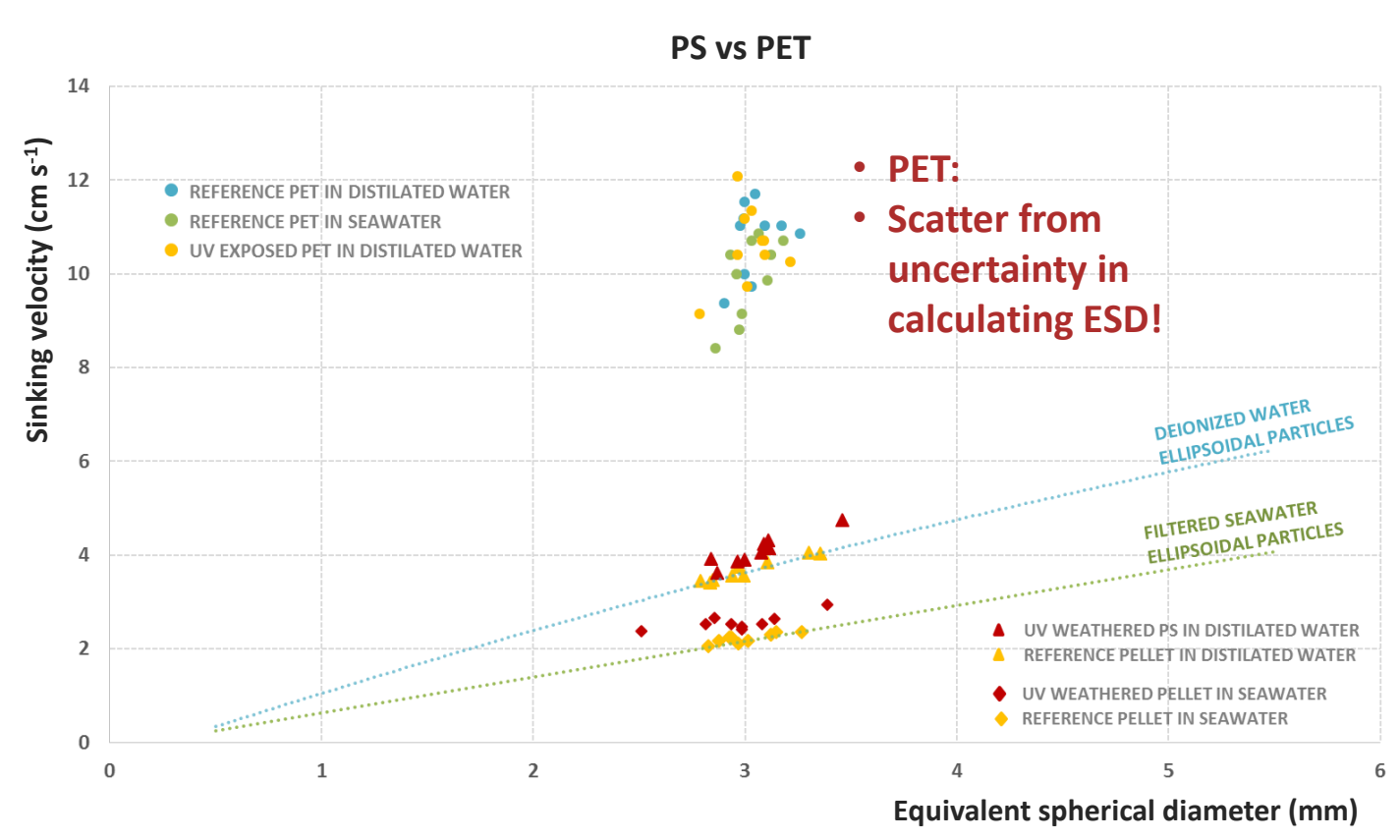
Results: Outdoor UV aging of PS granules



Deionized water

Filtered Oslo harbor water

Results: PET vs PS granules



Conclusions this far on settling

- Particle size, shape and $\Delta(\rho_s - \rho)$ affects the sinking rate
- Dietrich model: Further modeling for irregular shapes is needed
- Weathering changes the sinking rate

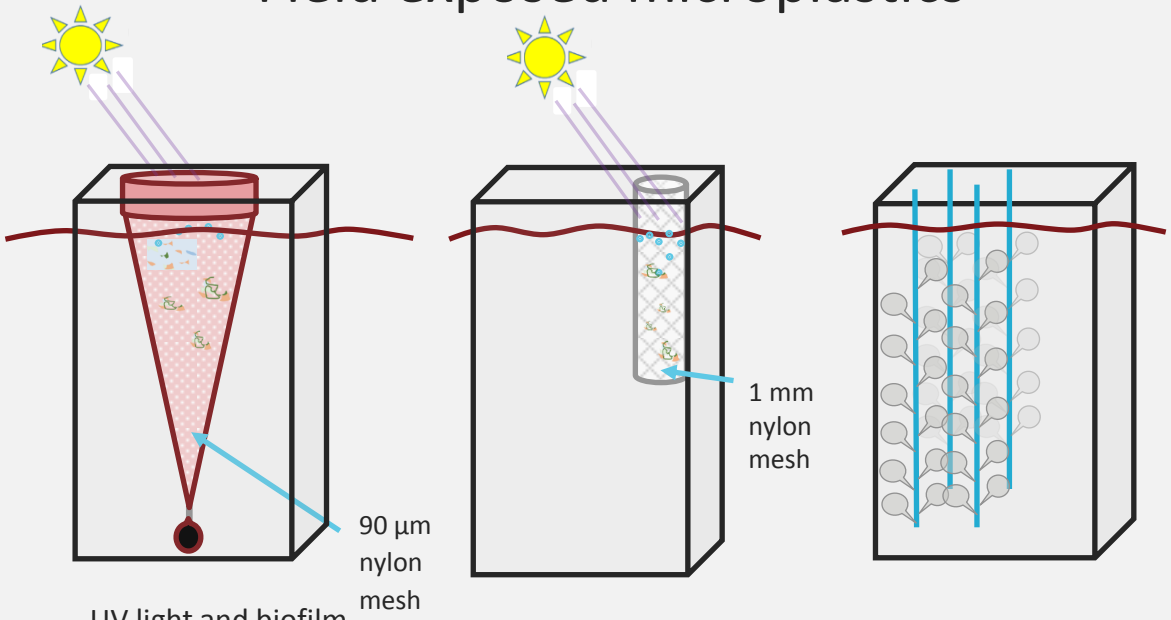
Future work

- Field exposed microplastics

PET granules
PE granules
PS granules
PP granules

PET fibers
PE fibers

PET powder
PE powder

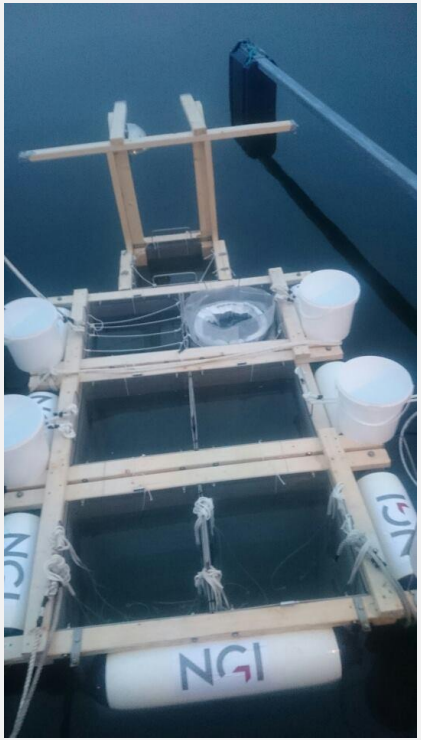


UV light and biofilm
Fragmentation
Aggregation and sedimentation

UV light and biofilm

Biofilm

Future work

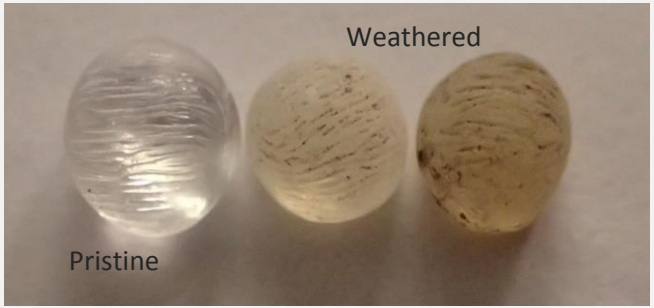


- Field exposed microplastics

Sample in 3 months (bioflim) and 6 months (biofilm + UV)

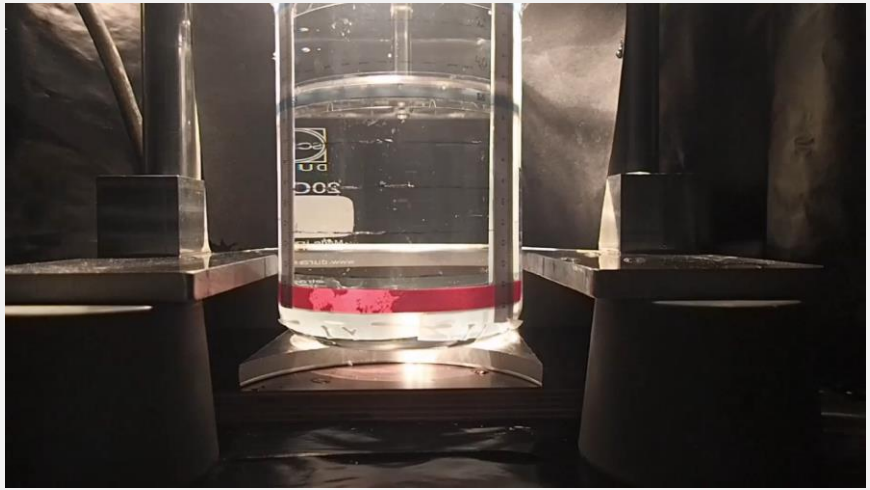
Future work

- Characterization of the weathered particles
- Turbulence



Polystyrene particles (PS) collected from NGI roof feb.2017 after 10 months

- Density difference?
- Change in brittleness?
- Change in surface properties?



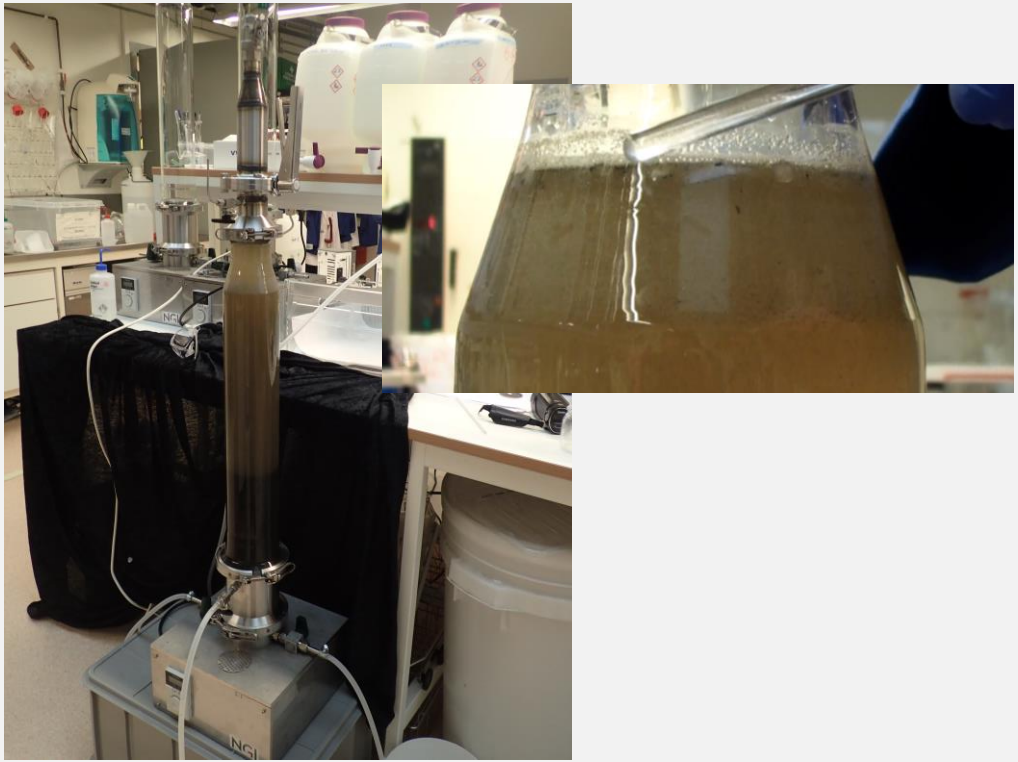
- How does turbulence influence the settling?

Field Samples in Oslo

- **Multinet sampler developed by University of Oslo**
- First cruise – Apr. 2016 Bekkelaget nets 8, 20 and 40m depth (nets 500 µm)
- Second cruise – June 2016 Bekkelaget (8, 20, 46 m) and Akerselva outflow (1, 9 and 14.5 m depth) with 90 µm nets

Speed = 2.3 knots, opening 50 x 20 cm

Methods: Sediment and plastic separation



Novel sediment separator

Filled with high density fluid; ZnCl2:CaCl2 (density 1.6)

Separates floating material (organic material and microplastic)

MSc. Sabnam Mahat

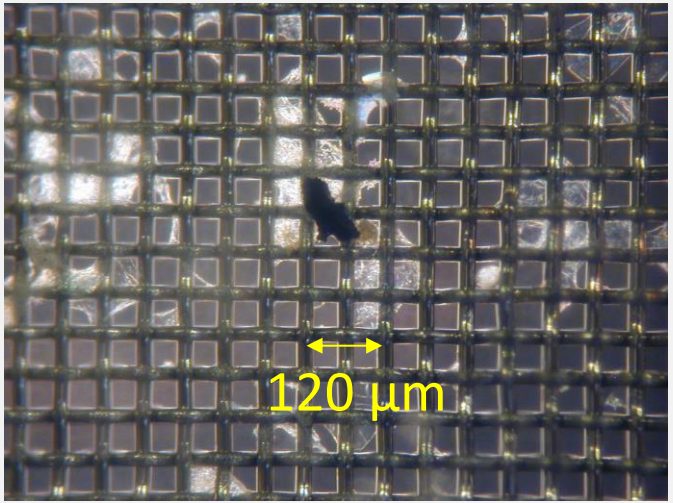
Results: Digestion of organic matter

- Before

Akerselva outflow 1m depth

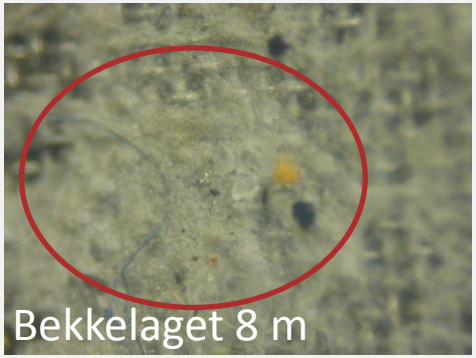
Samples on 45 µm steel mesh

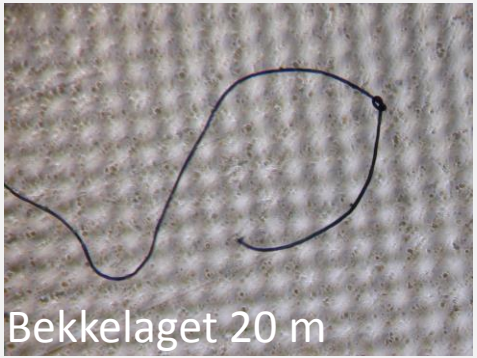
- After

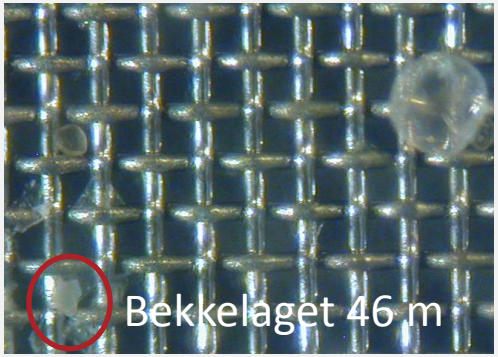


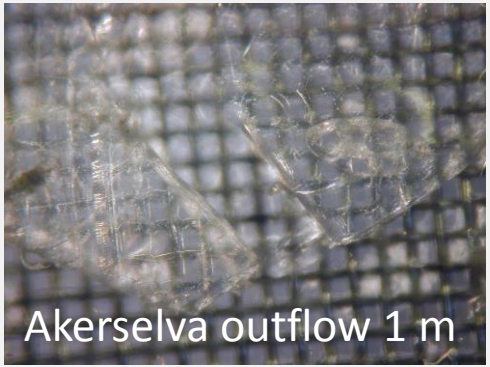
Most organics removed

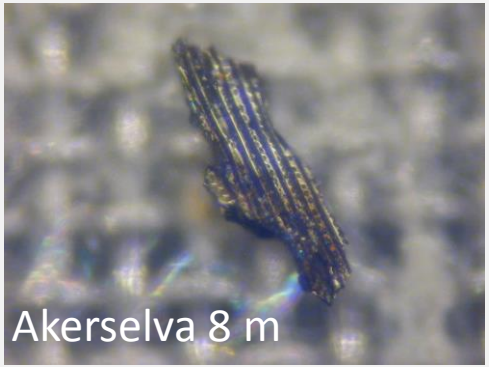
Results: Examples of interesting particles

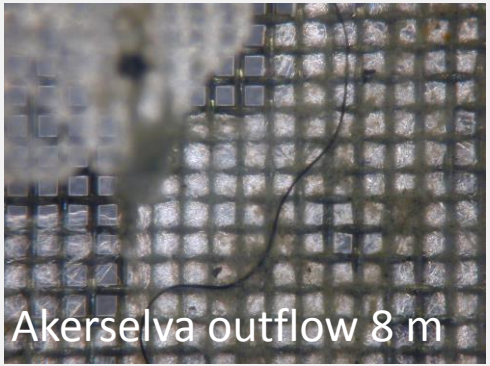








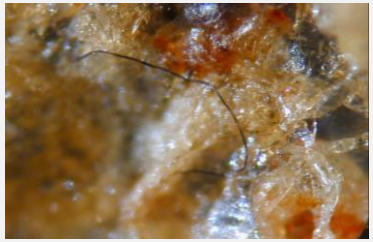




Results: Suspected microplastic fibers

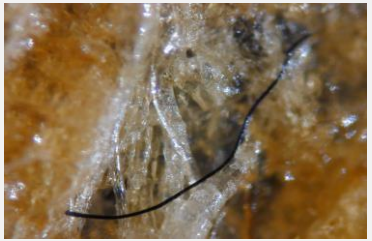
e.g. fibers at Bekkelaget

8 m

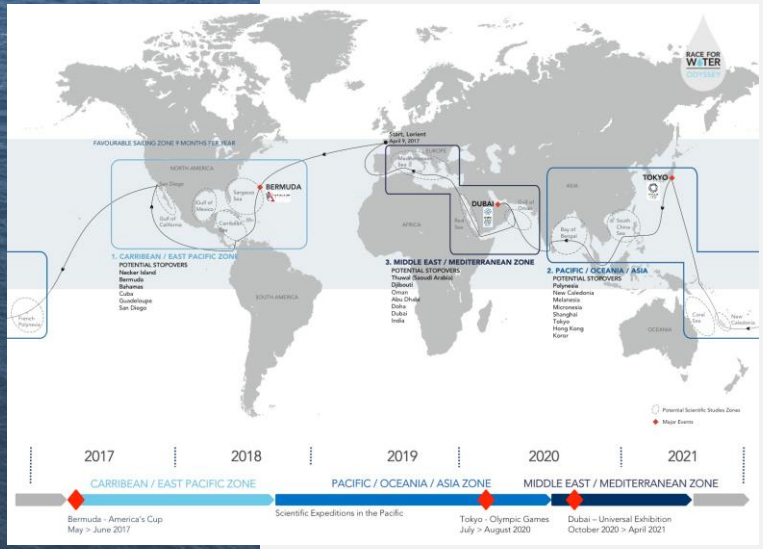


20 m

46 m

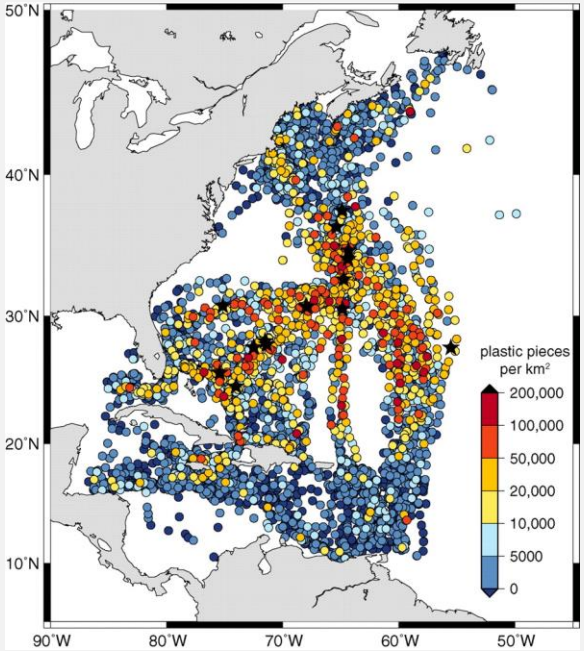


Bonus mission: Race for water



RACE FOR WATER
A FOUNDATION TO PRESERVE WATER

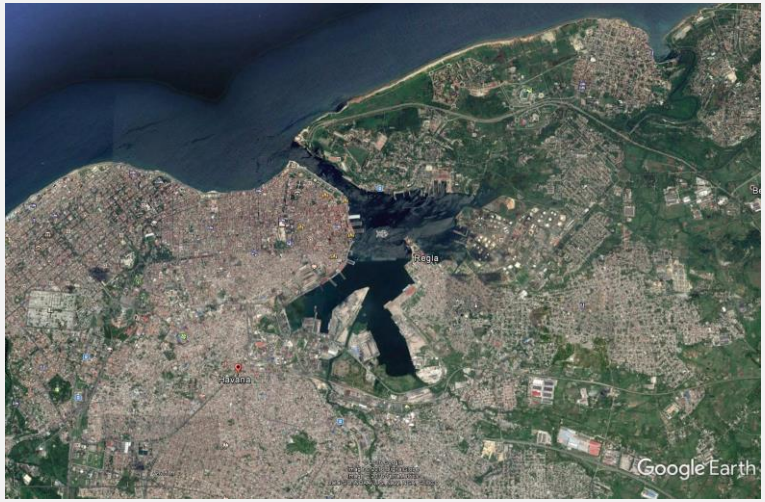
Bonus mission: Race for water



Law et al. 2010

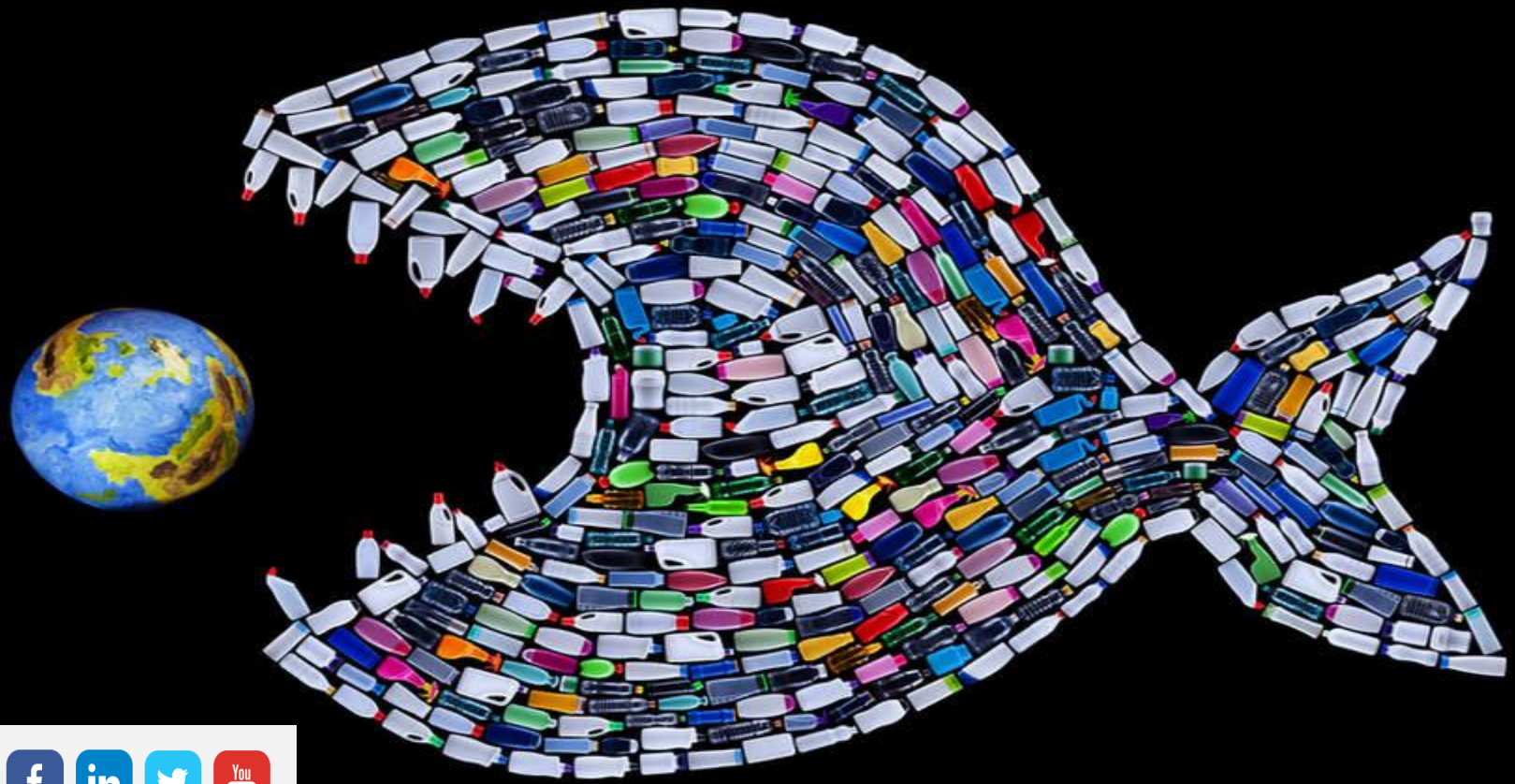
Havana – Aug/Sept 2017

- Water, plankton and sediment samples



Thank-you!

https://www.ngi.no/Prosjekter/WEATHER-MIC-mikroplastikk-i-marint-miljoe



NGI @infoNGI

Illustration: Nagy-Bagoly Arpad

@infoNGI

NORGES GEOTEKNISKE INSTITUTT
NGI.NO

Methods: Column experiments for settling rate

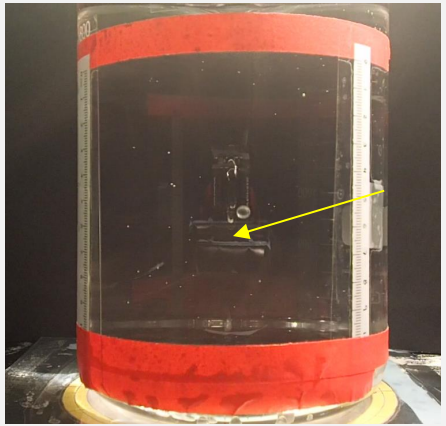
- Laboratory:

  Film-processing of single particles settling in a column (30 or 60 fps)

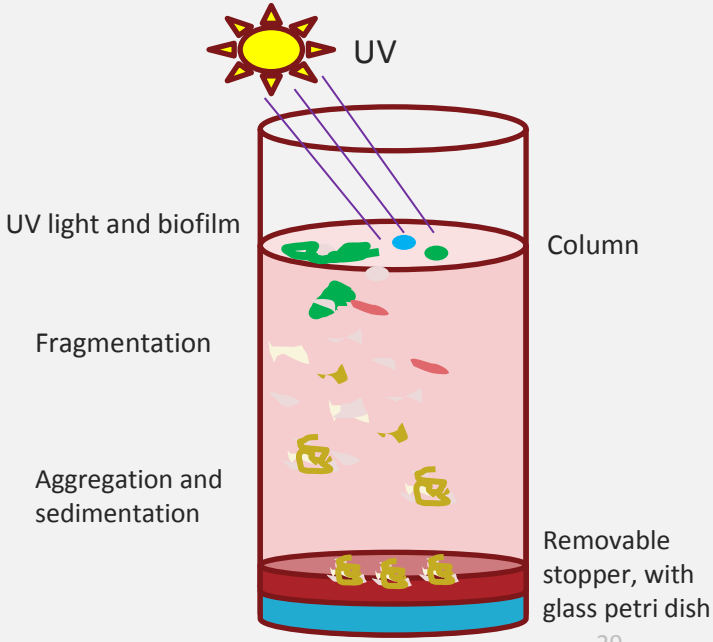
  f(particle density, shape, size)

  f(fluid density, turbidity, particulates, turbulence)

  f(effect of weathering)



10 cm beaker

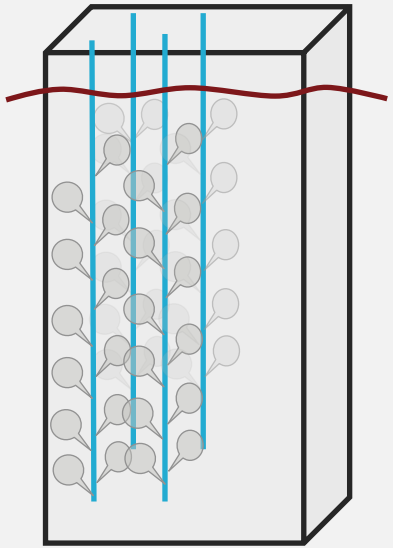


Field exposed microplastics in a mesocosm

PET granules
PE granules
PS granules
PP granules

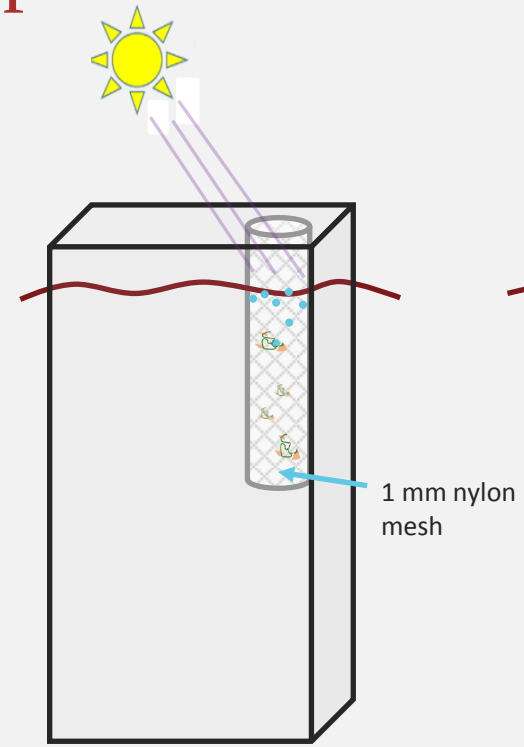
PET fibers
PE fibers

PET powder
PE powder

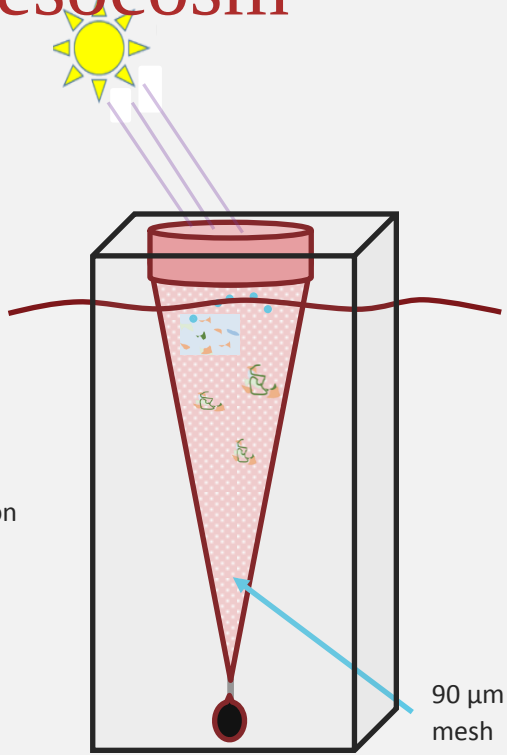


90 µm nylon bags
1 mm nylon bags

Biofilm



UV light and biofilm



UV light and biofilm
Fragmentation
Aggregation and sedimentation

Field samples in Oslo

- Raw water samples at depth
  - Sent to IKTS for Dynamic Image Analysis
- Sediment trap samples
  - Obtained but not been processed yet
- Surface water plankton trawl samples
  - Collaboration with Martin Hassellöv and Therse Karlsson, U Götheberg, who is currently analyzing them (will get his data in # / km2 and as # / m3 and samples)
- Sediment core samples
  - Have not been processed yet