The Sinking Behavior of Fresh and Weathered Microplastics in Surface Water

The influence of weathering on MP aggregation and settling

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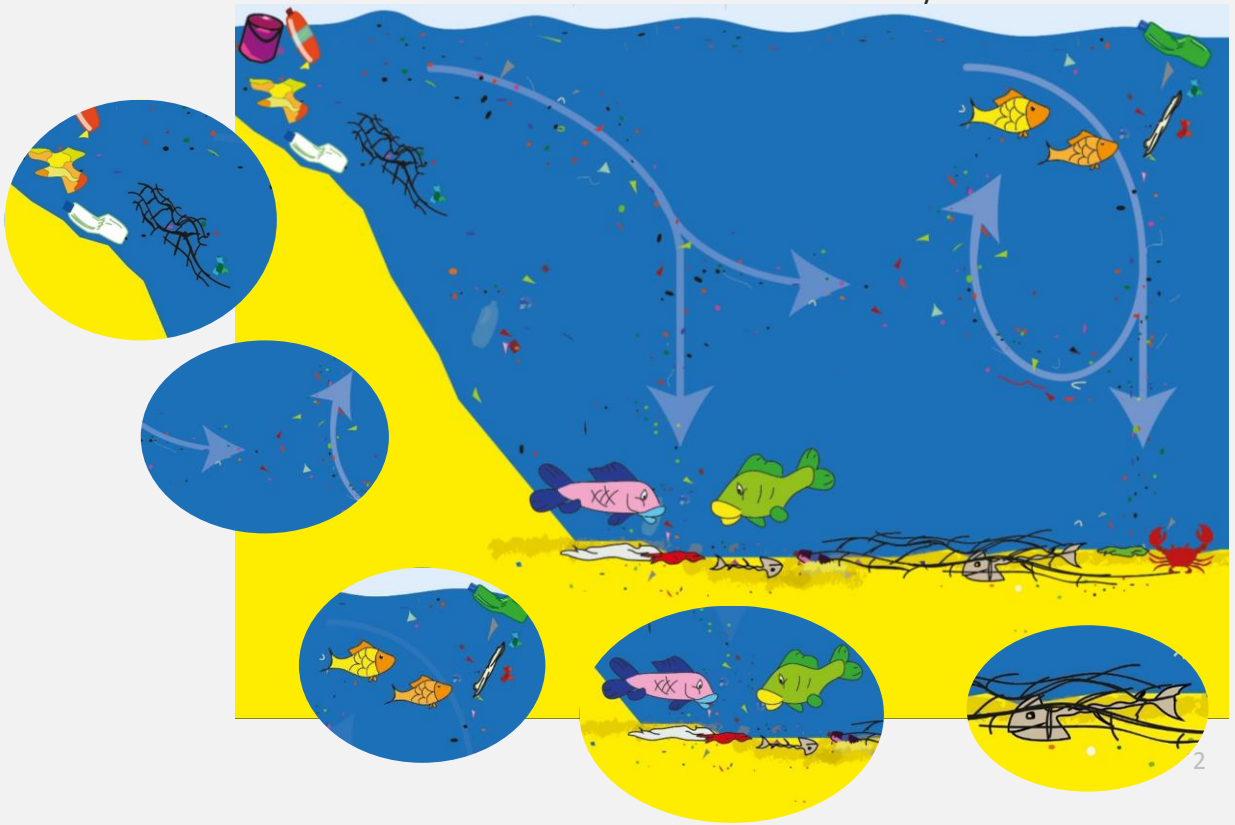
How can weathering change the sinking behavior of microplastic particles of different shape, material and density?

- Increasing amount of plastic litter
- Fragmentation generates microplastics
- Unknown subsurface processes
- Ingested by marine biota

By Linn Merethe B.Olsen



- Analogue experiments to determine the sinking velocity of different types of plastic materials in different fluids
- Illustrate the effect of weathering on the sinking velocity
- Generate data that will be used to developed 1D microplastics fate models

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)

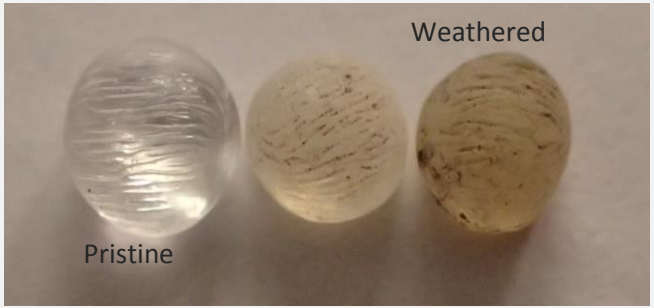
Weathered particles

UV aged

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

Weathered microplastics

- UV aging (IKTS, Stockholm University, NGI)



Polystyrene particles (PS) collected from NGI roof feb.2017 after 10 months, exposed to natural conditions

Column experiments for settling rate

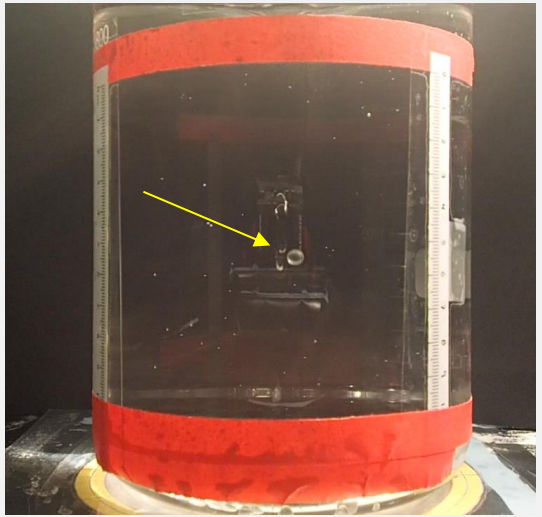
Laboratory:

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

f (particle density, shape, size)

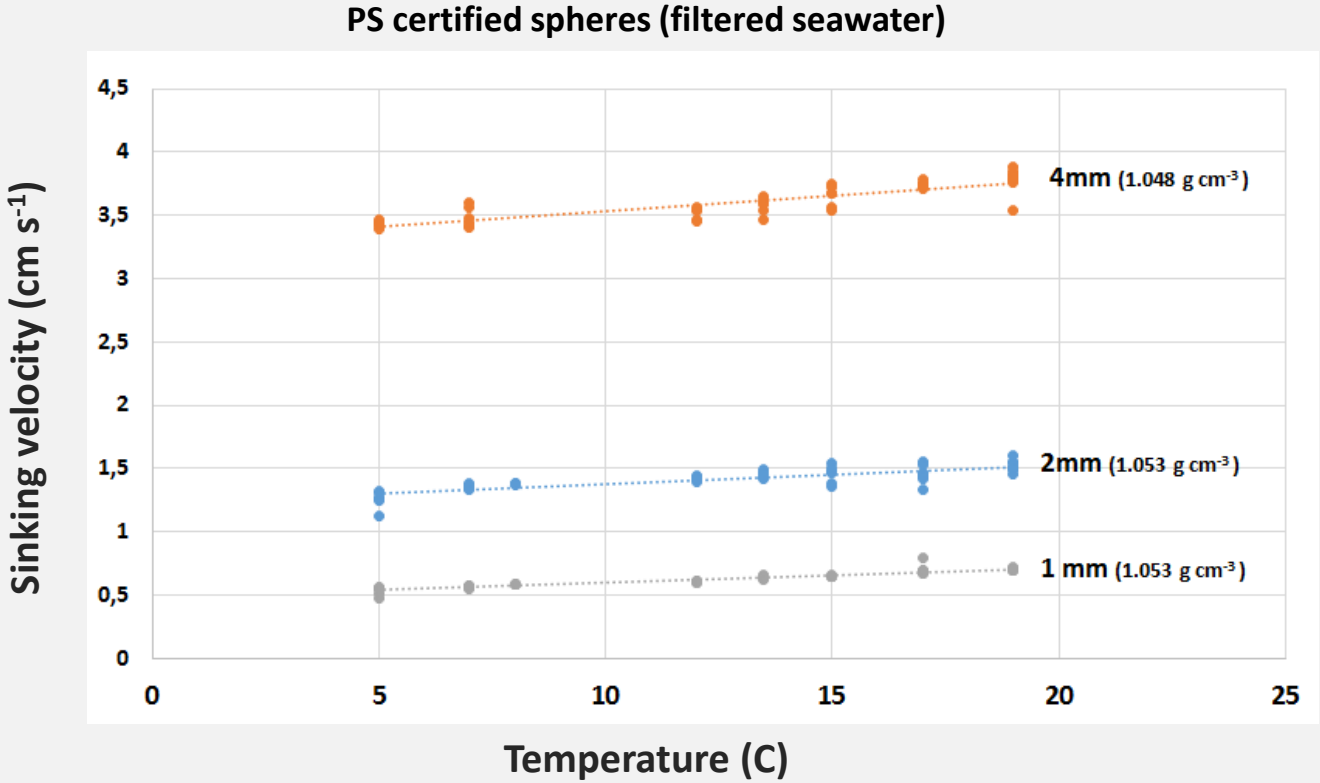
f (fluid density, turbidity, particulates, turbulence)

f (effect of weathering)



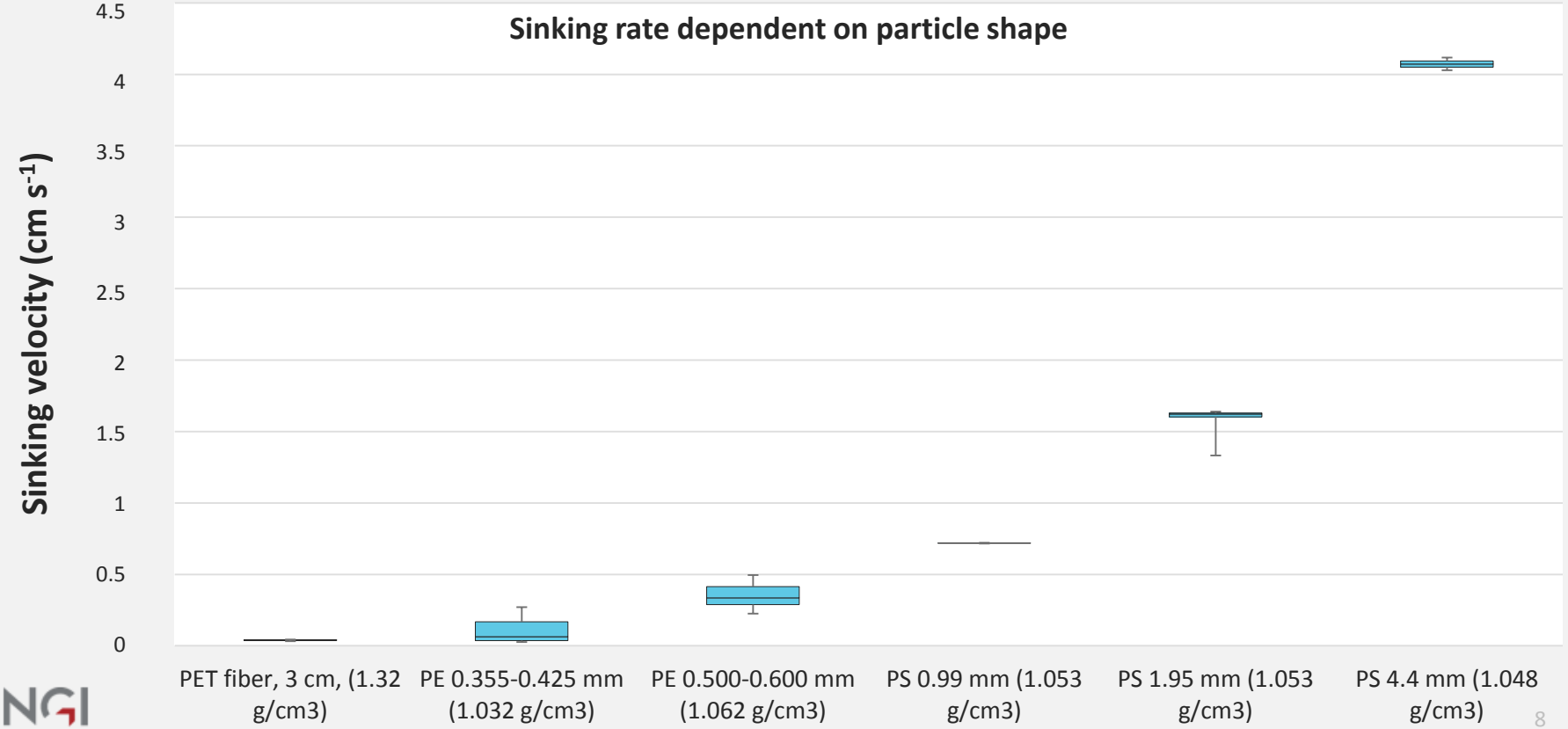
10 cm beaker

Effect of particle size and temp/density



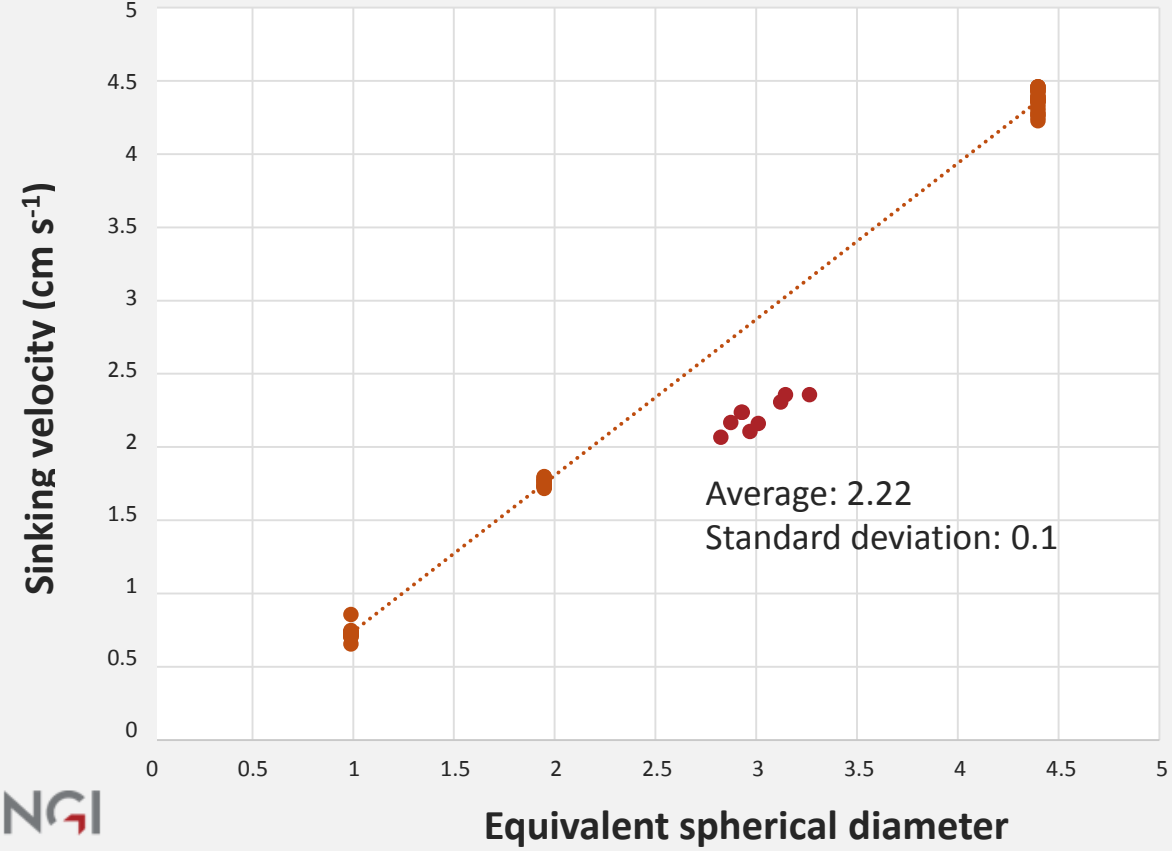
Particle shape

Filtered seawater, room T



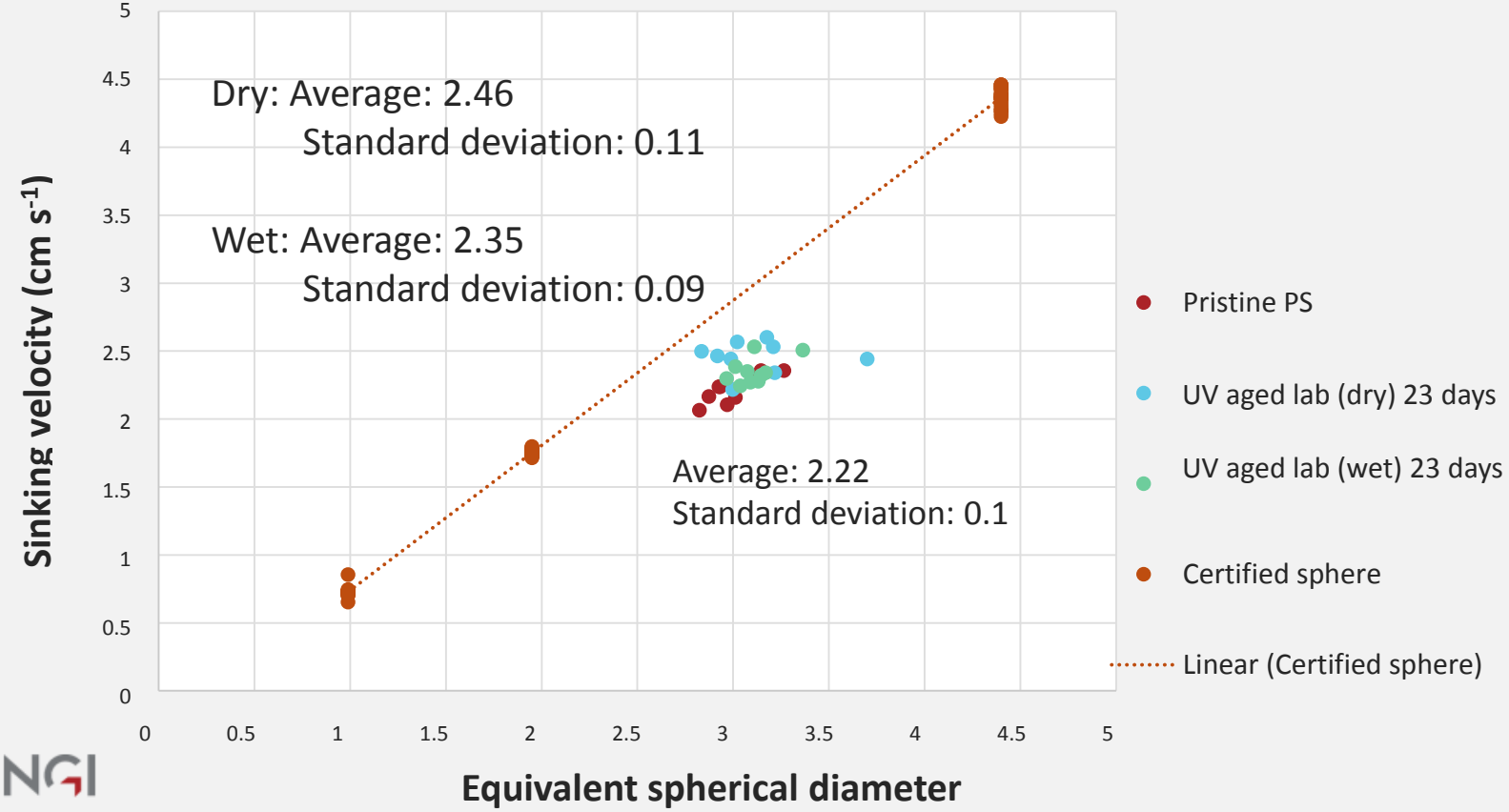
Pristine polystyrene nurdles

Filtered seawater, room T



Weathered polystyrene nurdles

Filtered seawater, room T



Weathered polystyrene nurdles

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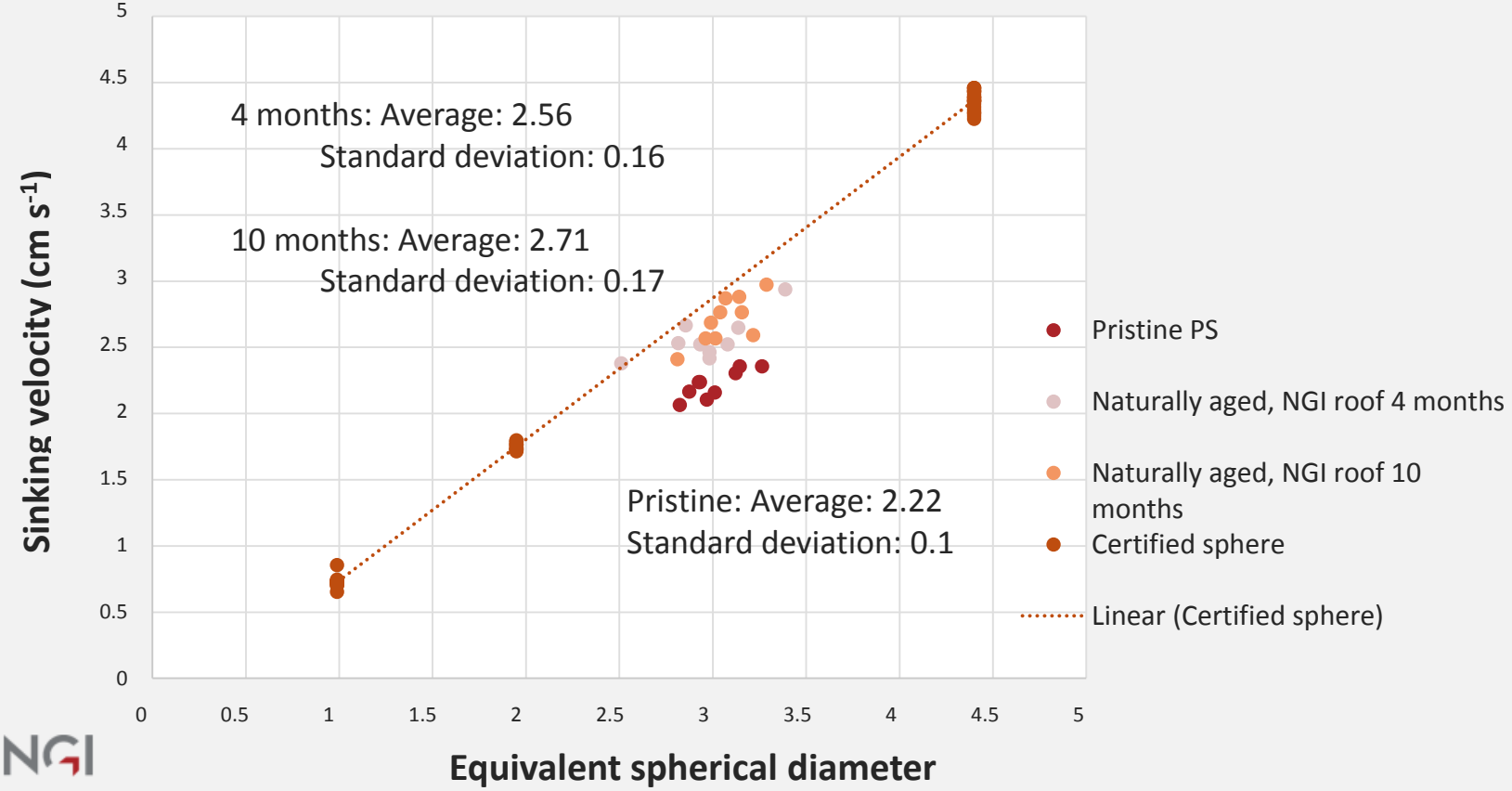
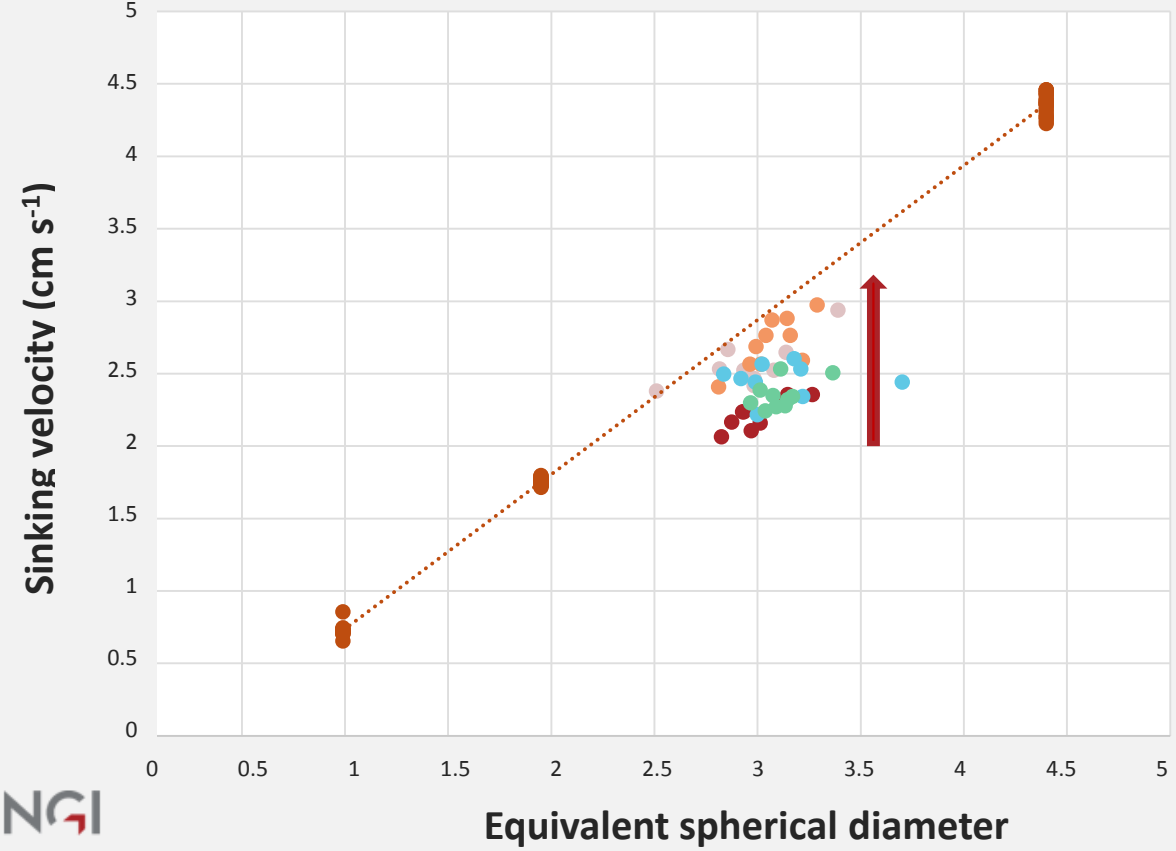


Weathered polystyrene nurdles

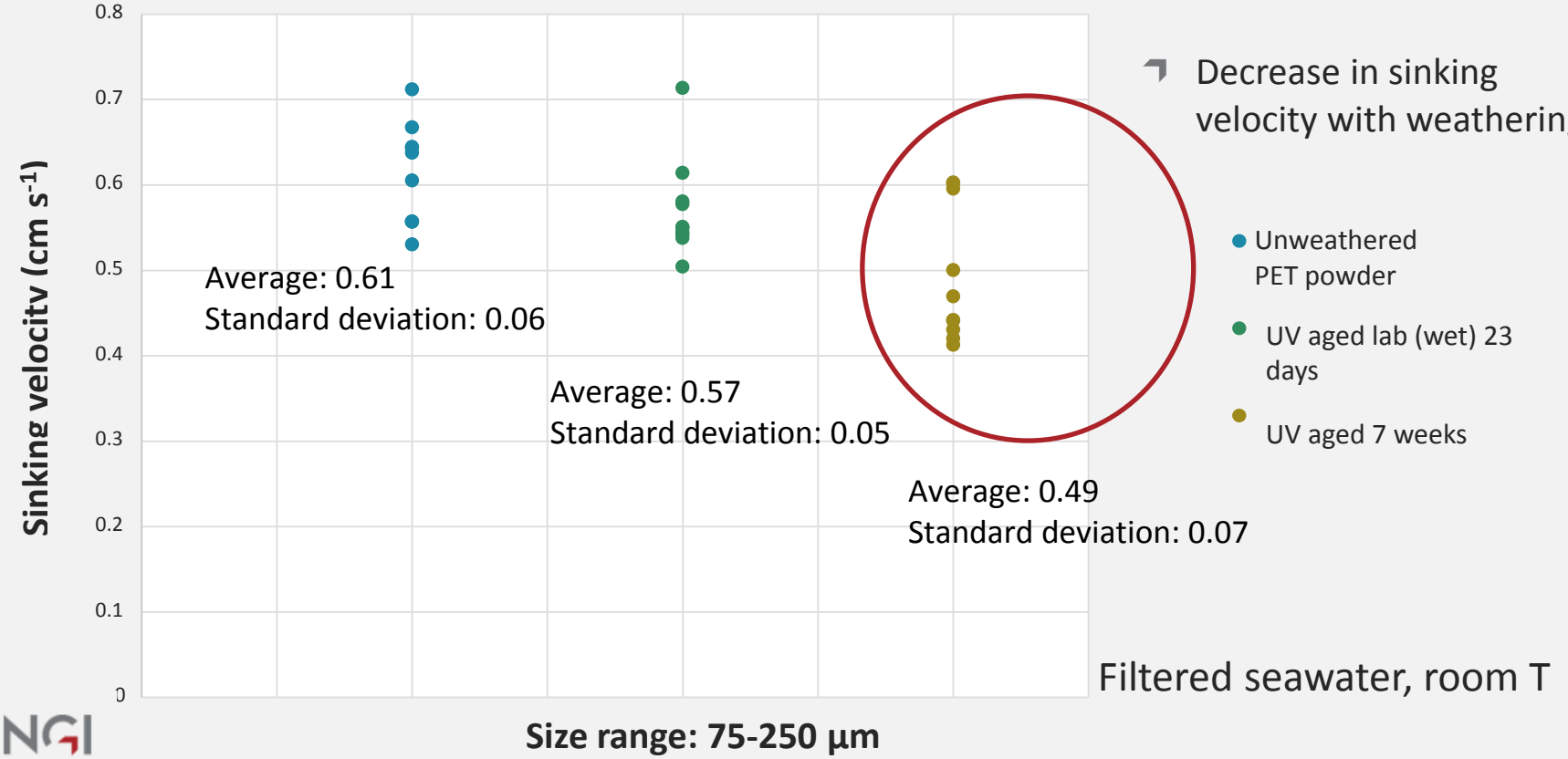
Filtered seawater, room T



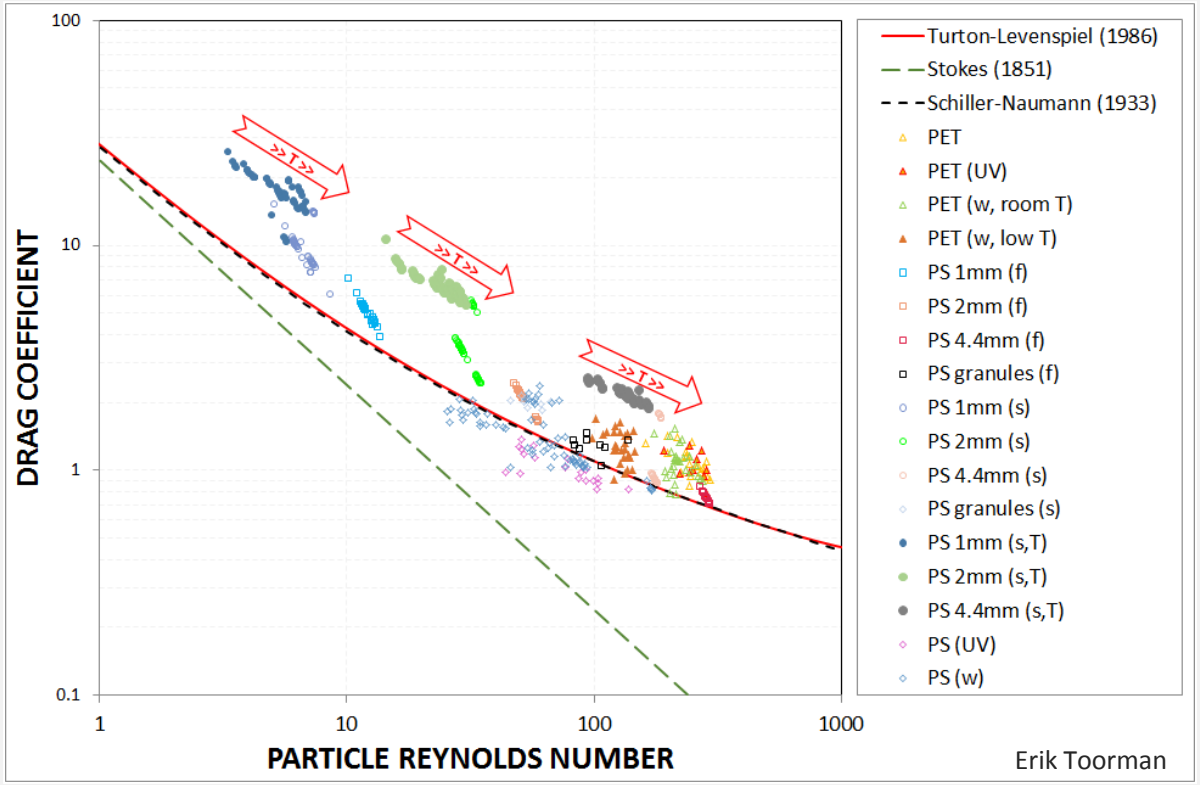
Weathered polystyrene granules have faster average sinking velocity

- Pristine PS
- Naturally aged, NGI roof 4 months
- Naturally aged, NGI roof 10 months
- UV aged lab (dry) 23 days
- UV aged lab (wet) 23 days
- Certified sphere
- Linear (Certified sphere)

Weathered and unweathered PET powder



Preliminary model



$Re = puL/\mu$

p: density of the fluid

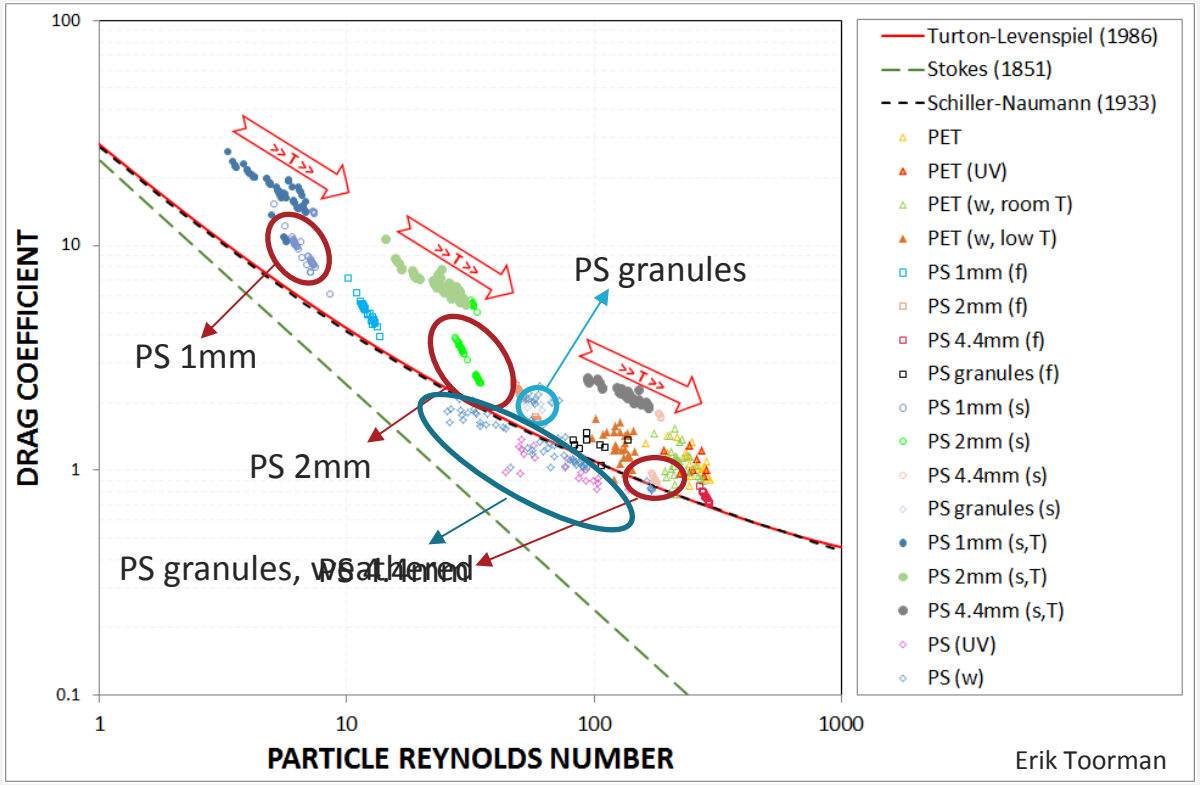
u: velocity of the fluid

L: characteristic linear dimension

μ: dynamic viscosity of the fluid

Takes into account different particles in different fluids

Preliminary model



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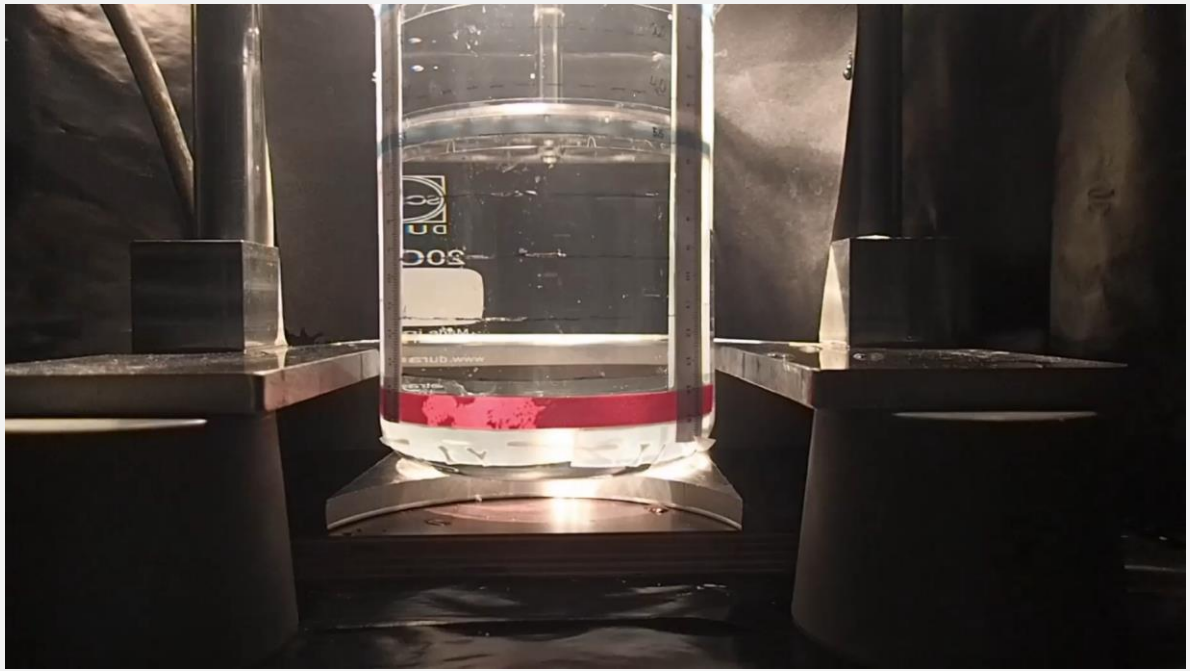
Takes into account different particles in different fluids

Weathering changes the sinking velocity for different types of microplastic material

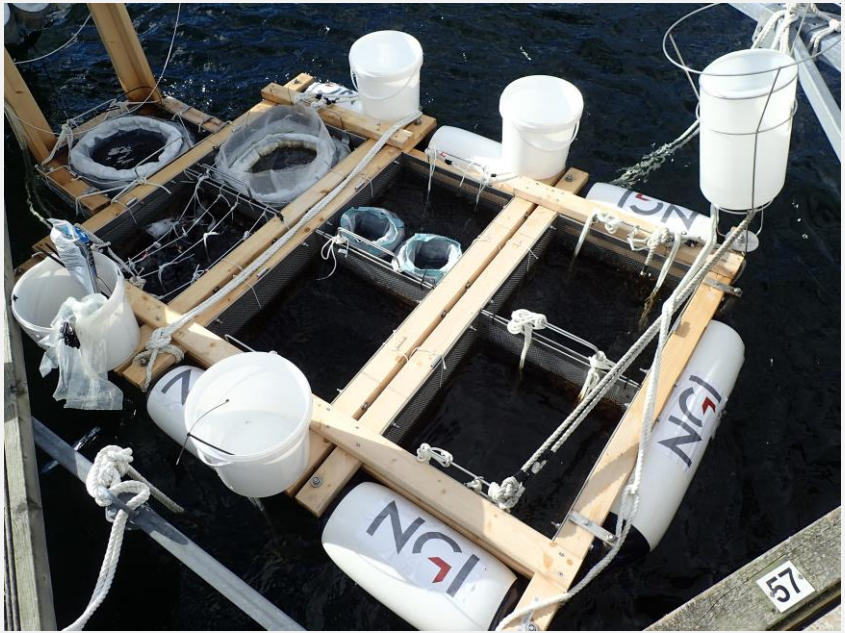
- UV aging may influence sinking, due to change in density and possibly hydrophilicity
- Particle size has a larger influence than UV aging
  - UV aging leading to fragmentation of bigger particles will slow down the sinking rate

The roll of turbulence is expected to play a key role in the fate of microplastics

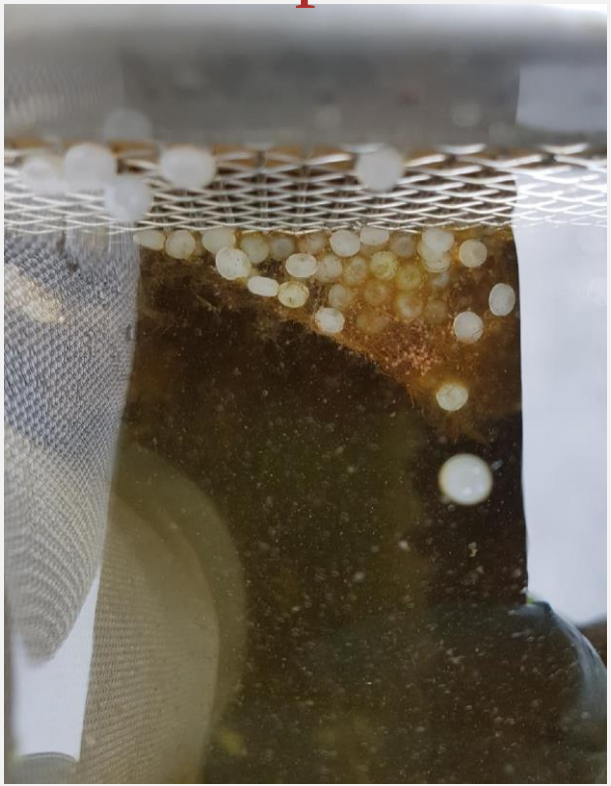


Field exposed microplastics

- UV aging likely less important than growth of biota



Field exposed microplastics



- Growth of biofilm can possibly be affect the sinking behaviour of microplastics
- LDPE kept underneath the surface due to algae growth

Acknowledgments

http://www.jpi-oceans.eu/weather-mic

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Results from analyses

- IKTS: change in crystallinity PET powder 41+-1% (pristine), to 44+-1 from UV 28 days.
- IKTS: PET powder aged for 23 days 1.44 g/cm3, pristine 1.43 g/cm3
- PET granules pristine: 1.40 g/cm3
- PET wet aged 23 days: 1.41 g/cm3
- PET dry aged 23 days: 1.41 g/cm3
- PS g pristine: 1.05
- PS g W aged 23 days: 1.06
- PS g D aged: 1.05
- PET powder aged 21 days with artificial seawater: 1.44
- PET powder aged 7 weeks (SU) 1.39
- Accuracy: +/-0.02 g/cm3. Only PET g vs PET powder, and new PET pow new vs aged 7 weeks