

15TH IBP PHD CONGRESS



UNLOCKING THE SECRET OF ELEMENTS

12 TALKS AND 31 POSTERS

14TH April 2023
Eawag, Dübendorf, 8:30 am – 7 pm

WARM WELCOME

Welcome to the 15th IBP PhD Congress at Eawag in Dübendorf, where we will unlock the secrets of elements! Get ready to explore the fascinating world of our environment and dive into the latest and greatest research in the fields of biogeochemistry and pollutant dynamics.

Our Congress promises to be a fun-filled event, with plenty of opportunities to connect with peers, meet new people, and gain fresh perspectives on the latest research at the Institute of Biogeochemistry and Pollutant Dynamics (IBP).

So, let's unleash the power of elements and discover the wonders of nature!



HiWis: Eliane Ballmer - Sofia Ambrogetti

Chairs: Anish Ajay Kirtane - Sébastien Giroud

Organisers: Emma Chollet Ramampandra - Sven Lukas Mosimann - Sarah Descloux

Program



8:30 ○ Registration
Eliane Ballmer – Sofia Ambrogetti

 **FC Atrium**

9:00 ○ Welcome by chairpersons
Anish Ajay Kirtane - Sébastien Giroud

 **FC C20**

Opening Address
Prof Dr. Kristopher McNeill



9:20 ○ Talk session 1

 **FC C20**

Katrin Schulz
How Does Adsorbed Phosphate Impact Iron
Oxyhydroxide Transformations in Paddy Soils?

Jill Bachelder
How does organic fertilizer composition impact
Zn and Cd uptake in wheat?

Johannes Rath
Bioaccumulation in aquatic invertebrates: impact
of climate, uptake pathway and spatial distribution.



10:20 - ○ Short break

 **FC Atrium**



10:40 ○ Talk session 2

 **FC C20**

Joel Wong Meng Cheng
Recent Column-Compound Extremes in the
Global Ocean.

Grégoire Saboret
Amino acid stable isotopes track the source and
fate of organic matter in ecosystems.

Duncan Dale
Treasure from trash: Using nuclear waste to trace
ocean circulation around Iceland.



11:40 ○ Poster session A and coffee

 **FC Atrium**



13:00 - ○ Lunch
14:00

 **AQA**



14:10

Talk session 3



FC C20

Xinjie Wang

Differentiating microplastics from natural particles in aqueous suspensions using flow cytometry.

Esther Greenwood

Estimating Safe Drinking Water Coverage using Household Survey and Earth Observation Data.

David Mennekes

The dark side of (modelling) review papers.



15:10

Poster session B and coffee



FC Atrium



16:30

Talk session 4



FC C20

Nikola Obradović

Peat particulate organic matter reduction and methane formation – field and laboratory study.

Joëlle Kubeneck

Effect of Mn and Mg substitution on vivianite transformation under sulfidic conditions.

Astrid Stubbusch

The nutritional benefit of killing.



17:30

Awards and Apéro



FC Atrium



19:00

Party!



Coconut bar



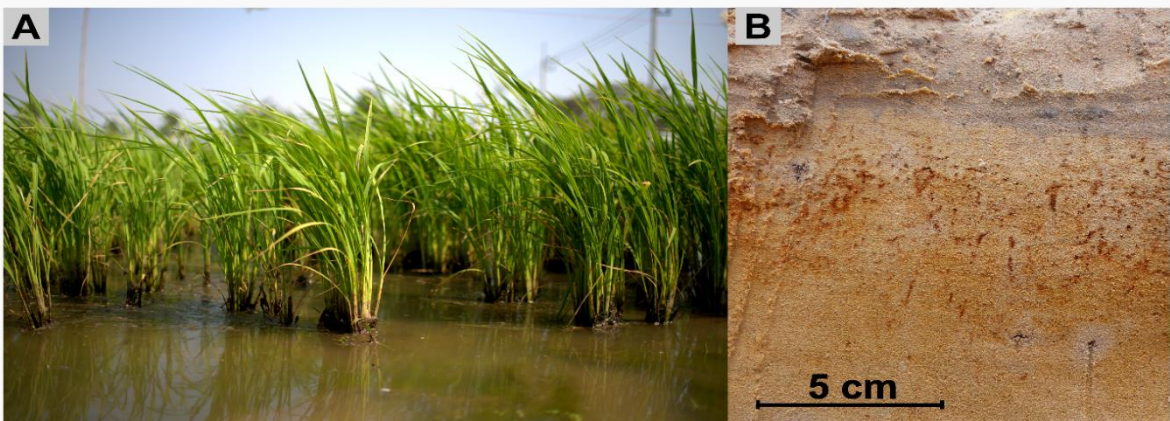
Presentations



Katrin Schulz
Soil Chemistry | ETH

How Does Adsorbed Phosphate Impact Iron Oxyhydroxide Transformations in Paddy Soils?

Iron (Fe) oxyhydroxide minerals, such as ferrihydrite, can govern nutrient and contaminant cycling in sub- or anoxic soil environments, where ferrihydrite can be reductively dissolved or transformed to more crystalline minerals, such as goethite. An important nutrient, which is often associated with Fe oxyhydroxides and can impact their transformation, is phosphate (PO_4^{3-}). Ferrihydrite transformations have been intensely studied in model systems but rarely in-situ in soils. We investigated how ferrihydrite transforms in soil under field conditions and how adsorbed PO_4^{3-} impacts mineral transformations. We mixed ^{57}Fe -labeled ferrihydrite, with or without adsorbed PO_4^{3-} , with soil and incubated it in a flooded rice paddy soil in Thailand. At multiple time points, the samples were analyzed with ^{57}Fe Mössbauer spectroscopy to track the solid-phase speciation of ^{57}Fe , and geochemical conditions were monitored in porewater. After four months, 30% of the ^{57}Fe in ferrihydrite samples was present as goethite, which contrasts faster mineral transformation in laboratory model experiments. When PO_4^{3-} was pre-adsorbed, reductive dissolution of ferrihydrite was enhanced and mineral transformation to goethite was strongly hindered. The results indicate a dual role of PO_4^{3-} during Fe mineral transformations in soils and demonstrate that mineral-associated PO_4^{3-} plays an important role in Fe cycling in soils.

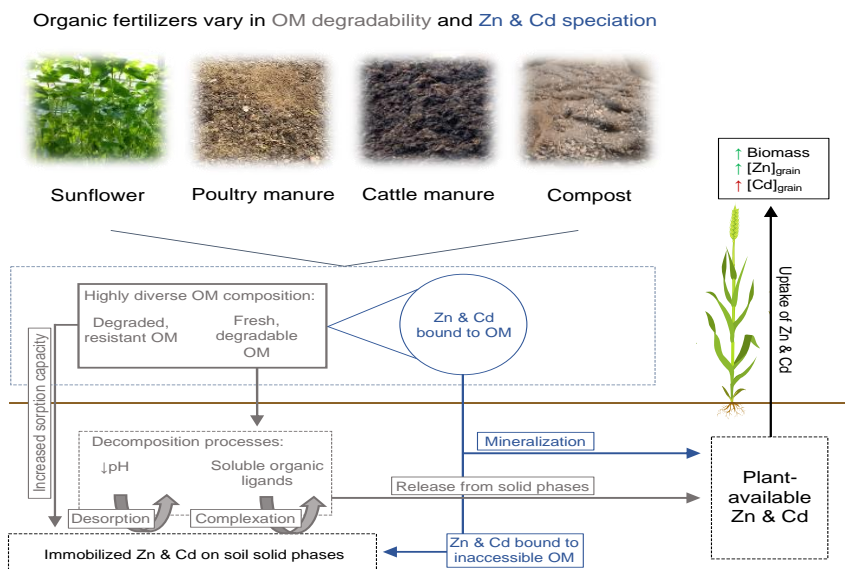


A flooded rice paddy field in Thailand (A) and typical hydromorphic features in a soil profile from a drained rice paddy field (B).



How does organic fertilizer composition impact Zn and Cd uptake in wheat?

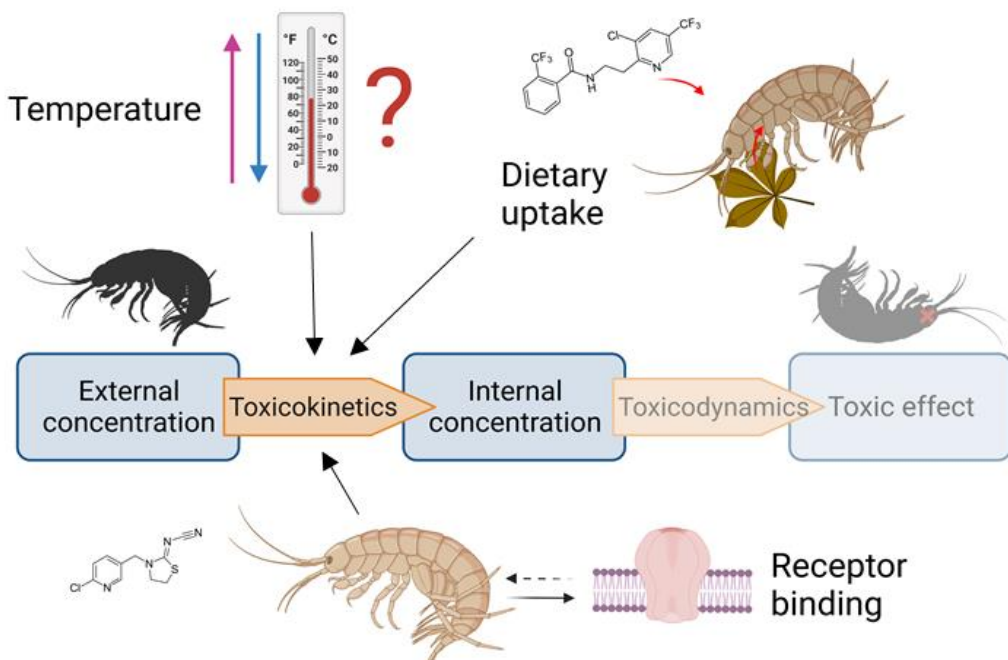
Wheat grown in Zn-limiting conditions can lead to decreased nutritional value of resulting food products. Organic fertilizer application can increase soil bioavailable Zn either directly, via addition of Zn from the fertilizer, or indirectly, via solubilization of Zn from soil solid phases. However, this may increase the bioavailability of Cd, a toxic element with similar biological uptake pathways as Zn. We performed a wheat-growth pot experiment to understand how the composition of organic fertilizers impacts bioavailable Zn and Cd. Four organic fertilizers (sunflower, poultry manure, cattle manure, and compost) with highly different chemical compositions were applied to a low-Zn soil. Soil extractions with water and DGT samplers were performed after eight weeks of wheat growth to measure potentially bioavailable Zn/Cd pools. Binding of Zn/Cd to organic matter (OM) in water extracts was measured using SEC-UV-ICP-MS/MS1. Organic fertilizer application did not increase soil DGT-Zn/Cd but did increase Zn/Cd bound to water-soluble OM. All organic fertilizers except compost increased Zn/Cd concentrations in wheat grains. Isotope source tracing revealed the pathway of Zn/Cd increase (direct vs. indirect) varied depending on the fertilizer. Our results have demonstrated that soil processes controlling bioavailable Zn/Cd are intimately linked to the composition of organic fertilizers applied.





Bioaccumulation in aquatic invertebrates: impact of climate, uptake pathway and spatial distribution.

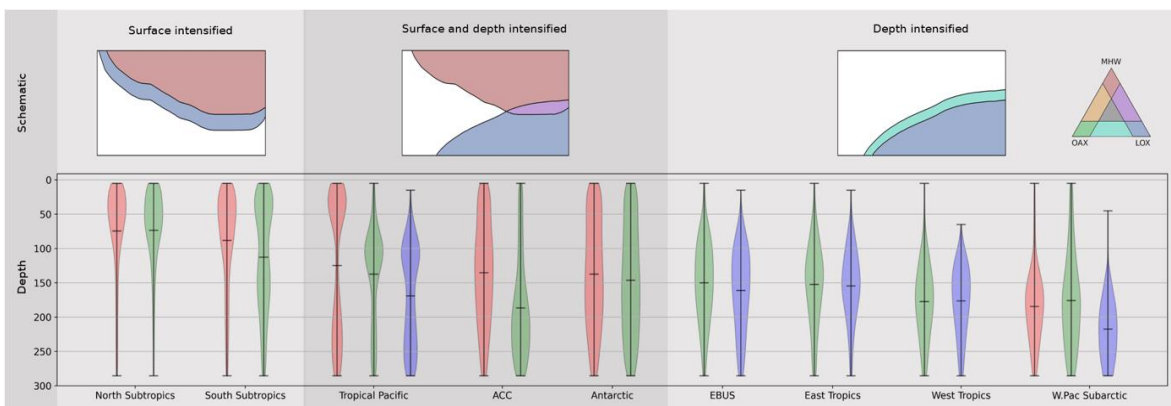
Toxicokinetic processes determine internal concentrations in organisms exposed to contaminants. Subsequently, internal concentrations determine potential toxicological effects. Internal concentrations in aquatic invertebrates are often observed to be higher in the field than expected based on extrapolations from laboratory experiments, which indicates an underestimated ecotoxicological risk for aquatic communities. We assessed different parameters that influence toxicokinetics but are not considered in the standard risk assessment based on highly standardized laboratory experiments. Temperature was found to be an important driver of toxicokinetic processes in aquatic ectotherms, indicating a high exposure risk during run off events from agricultural fields in summer. Additionally, it was demonstrated that dietary uptake of systemic pesticides from contaminated leaves may impose a higher exposure risk towards detritivores during autumn than uptake from water. Furthermore, irreversible receptor binding caused a strong underestimation of neonicotinoid insecticide bioaccumulation over time compared to laboratory experiments. This mechanism may also cause previously observed delayed toxicity. Model implementations for the three different elucidated toxicokinetic processes were provided in order to predict internal concentrations under different exposure scenarios and support their consideration in the environmental risk assessment.





Recent Column-Compound Extremes in the Global Ocean.

Marine extreme events can be detrimental to organisms and ecosystems across the global ocean. Marine heatwaves, ocean acidity, and low oxygen extremes are superimposed on the already changing trends of temperature, pH, and oxygen. When they concurrently occur in the vertical column, the habitable space for marine organisms is severely reduced. We use daily output from a hindcast simulation (1961–2020) from the Community Earth System Model coupled with Biological Elemental Cycling to characterise such compound extremes. Extreme conditions are identified on a moving baseline and relative threshold, with an additional threshold of $150 \mu\text{mol}$ for low oxygen conditions. In the vertical column, at least 50 m out of the top 300 m is required to be extreme for each stressor. Such an event is termed a column-compound extreme event (CCX). On average, 1% of the global ocean volume is occupied by CCXs and up to 5% at maximum. On a fixed baseline these values increase to 8% and 27%. In many regions, CCXs decrease habitable space by up to 75% and have high intensity index of more than 2. The global volume of CCXs is expected to increase in the future, exacerbating impacts and reducing habitable space of marine organisms.



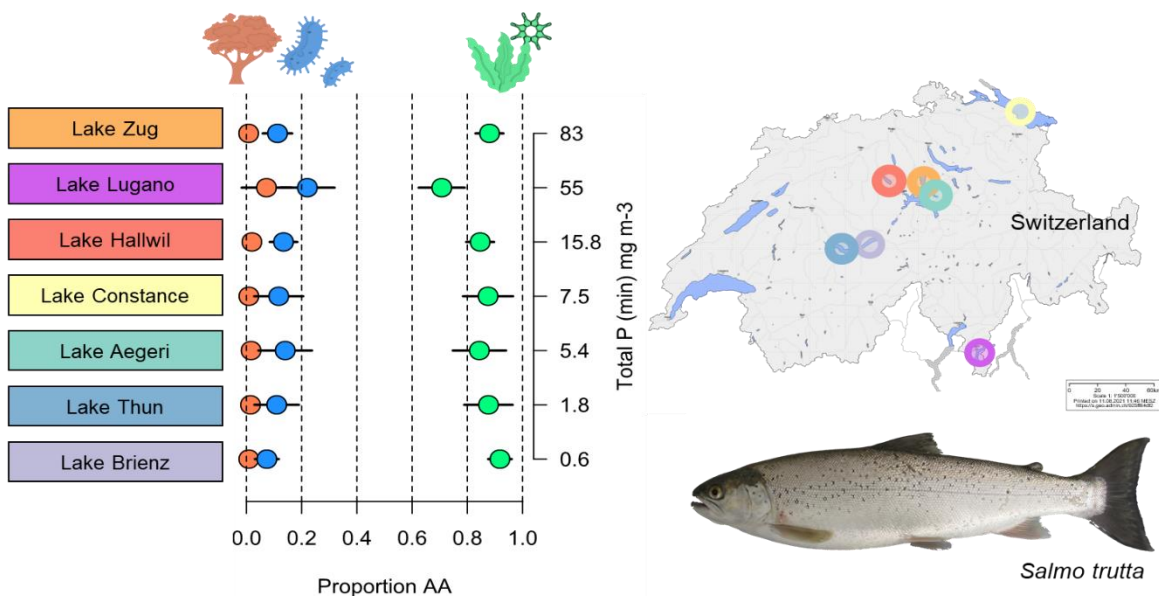
Intensity-weighted counts of single extremes during CCXs in regions with high extreme frequency.



Amino acid stable isotopes track the source and fate of organic matter in ecosystems.

Rivers and lakes receive nutrients and organic matter from other ecosystems like terrestrial ones. However, human activities such as eutrophication, changes in land use, and disruptions to the migratory movements of some species, disturb these allocations. Determining the fate and changes of these allocations remains challenging using bulk stable isotopes only. In using amino acid ^{13}C fingerprinting we characterize the source of primary production in food-webs. We apply this method to fish from peri-alpine lakes and show the importance of autochthony, highlighting the energetic constraints of aquatic food webs. Across a wide range of trophic status (~ 2 orders of magnitude range of phosphorus concentration), several lines of evidence suggested that perialpine lake food webs shared a common reliance on autochthonous ($86 \pm 9\%$) and bacterial production. In addition, we use amino acid nitrogen isotopes to measure trophic transfers in metazoans. We determine the importance of the microbial loop using alanine, a marker of protozoan food step.

Source of primary production

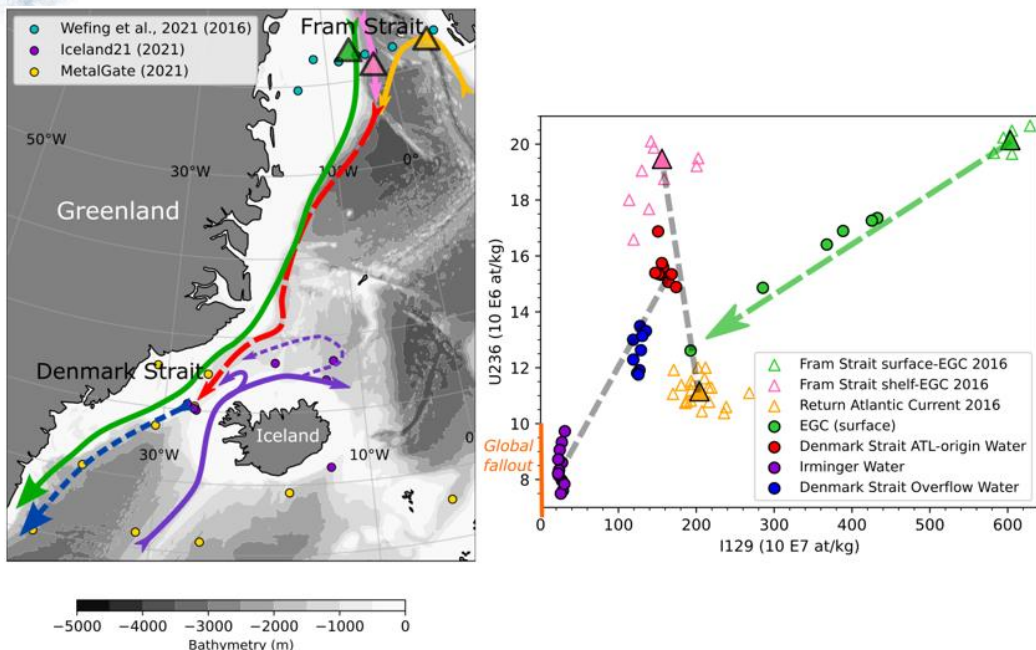




Treasure from trash: Using nuclear waste to trace ocean circulation around Iceland.

Iceland stands at an important gateway where Arctic and Atlantic waters interact. Atlantic waters pass northward and circulate in the Arctic before returning southward in the East Greenland Current. Zones of deep water formation in the Nordic Seas contribute to dense water overflows of the Iceland-Scotland Ridge. These are key processes regulating Arctic warming and deep ocean ventilation.

This system has been tagged with anthropogenic radionuclides iodine-129 and uranium-236 by bomb tests and nuclear reprocessing plants (NRPs) in France and the UK since the 1950s providing an opportunity to trace the origins and fates of water masses in the region. Here we present the results of measurements on samples taken during two cruises around Iceland in 2021. Models for the origin of waters transiting Denmark Strait and of the evolution of Iceland Scotland Overflow Water are presented that provide a tracer-based perspective for comparison with models based on physical oceanographic tools. This forms a baseline for tracking changes to circulation in the Subpolar North Atlantic using the transient nature of the tracer signals.



Major water masses (left) and their dual tracer signatures and mixing lines (right)



Xinjie Wang

Environmental Chemistry of Anthropogenic
Materials | ETH

Differentiating microplastics from natural particles in aqueous suspensions using flow cytometry.

Microplastics (MPs) in natural waters are heterogeneously mixed with other natural particles such as algal cells and natural minerals. An easy-to-use and fast method for identifying the existence of MPs and differentiating MPs from other particles are naturally present in the environment must be developed. In this study, we established a database of MPs optical properties either alone or in mixtures with natural particles by stain-free flow cytometry. The resulting high-dimensional data were visualized using the visual stochastic network embedding (viSNE) technique. The model particles comprised of 1) 9 different strains of freshwater algae, 2) mineral particles including clay, quartz, and ferrihydrite, and 3) MPs with various sizes (1 - 50 μm), morphologies (spheres, fragments, fibres) and polymer types (Fig.1 (a)). While this approach was unable to distinguish between different MPs size or polymer composition, we found all MPs variants could be distinguished from algae and mineral particles after viSNE analysis (Fig.1 (b)-(c)). We anticipate that this approach could be useful to provide high-throughput qualitative information about the presence of MPs in complex aqueous suspensions in order to screen for polymers, where more detailed follow-up analysis could be conducted by other means for samples which contained MPs.

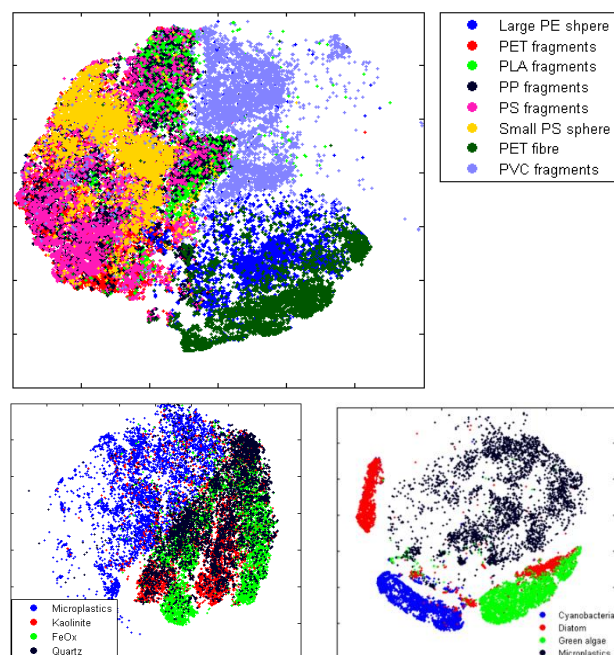


Fig.1 Visual stochastic network embedding map of (a) microplastics variants, (b) microplastics and mineral particles, and (c) microplastics and algae.



Estimating Safe Drinking Water Coverage using Household Survey and Earth Observation Data.

Access to safe drinking water is a human right and plays a core role in the United Nations' 2030 Agenda for Sustainable Development. Despite this, data on drinking water availability, accessibility and quality are only available for less than half of the global population, with considerable data gaps existing in low- and middle-income countries (LMICs). Here we predict progress towards universal access to safe drinking water in 134 LMICs through integrated use of Earth observation and nationally representative household survey data with a machine learning approach to generate geo-spatial maps highlighting subnational priority regions. Our analysis reflects variations in limiting factors to safe drinking water across geographical regions and points towards faecal contamination as the primary factor limiting access to safe drinking water in most parts of the world. Low coverage rates of safe drinking water dominate in rural areas with elevated temperatures and high annual variations of precipitation. Our maps portray how far we are from achieving universal access to safe drinking water and showcase the value of complementing household survey data with Earth observation data to provide estimates on progress towards universal drinking water access for the strategic allocation of resources for data collection and development.

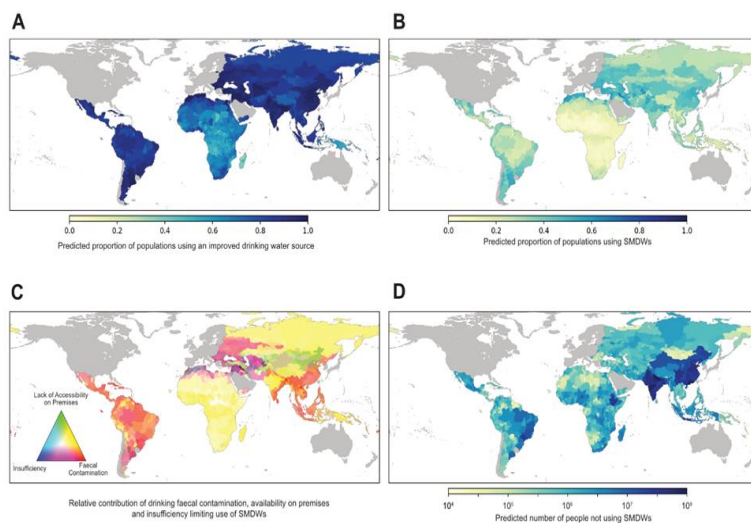


Figure 1A: Predicted proportion of population using an improved drinking water source in LMICs at global administrative area (GADM) level 1. Figure 1B: Predicted proportion of populations using SMDWs in LMICs at GADM level 1. Figure 1C: Relative contribution of three SMDWs subcomponents limiting full use of SMDWs in LMICs at GADM level 1. Areas which are coloured red are most affected by drinking water faecal contamination, green areas are mostly affected by lack of access to a drinking water source on premises and blue areas by insufficient availability of drinking water. A combination of the colours means that use of SMDWs is limited by multiple subcomponents. Figure 1D: Predicted number of people using SMDWs in LMICs at GADM level 1.

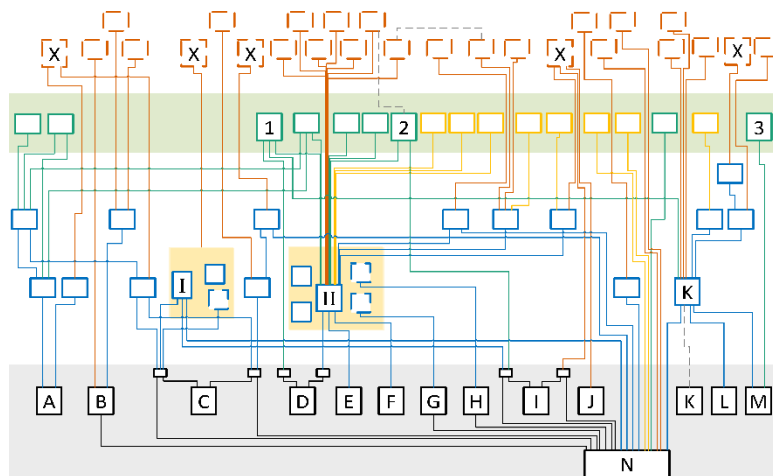


The dark side of (modelling) review papers.

Recently, different studies suggested that releases of car tire wear particle (TWP) emissions, as a type of microplastics, are about 60 times higher than all other microplastics releases into the environment. Consequently, TWP became a "hot topic" with an increasing number of publications.

In this work, I provide a closer look at the quality of all (14) recently (since 2000) published (European) country based TWP emission studies we found. We searched for all references and references of references which are used by these studies to derive TWP based results or data by using internet search engines, libraries and e-mail contact. As results, we found a shocking number of over 60 publications which were used as references. Only in very few cases (15%) the studies directly referenced original measurements. Moreover, half of the studies referenced are not available any more.

Through this work, I want to highlights the importance of understanding assumptions and input data in modelling studies given the example of TWP emissions. Hence, a recent published study might be based on much older sampling data which can easily lead to a misinterpretation of the results.

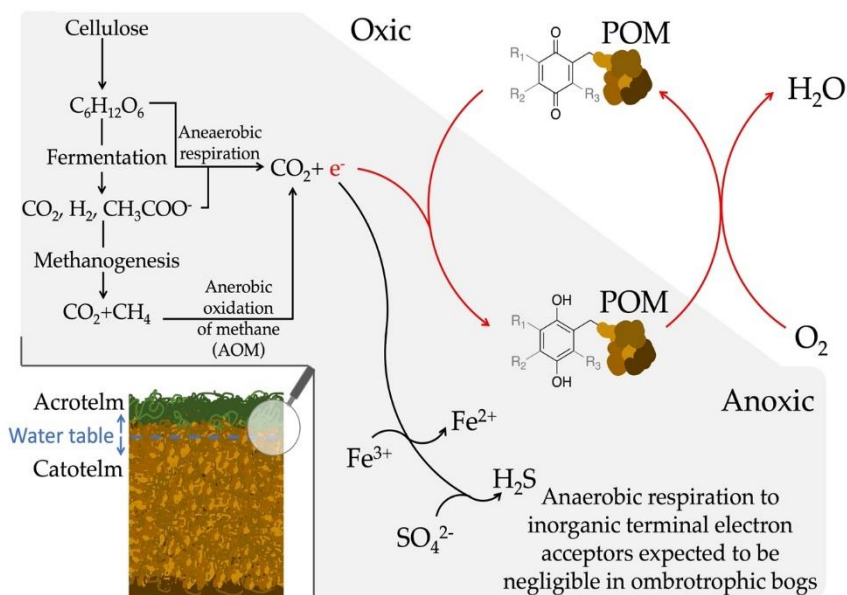


Starting from the bottom: The boxes marked "A" to "N" represent the Tire Wear Particle (TWP) emissions studies for Europe published after 2000. The lines on the top of each box are guiding to the boxes (=studies) which are cited to derive TWP emission data. While green boxes represent studies of measurements, the majority of studies is colored blue for review studies or red (dashed) for not available studies. Yellow boxes are representing studies that measured something else than TWP



Peat particulate organic matter reduction and methane formation – field and laboratory study.

Methanogenesis is expected to dominate carbon turnover in ecosystems where inorganic terminal electron acceptors (TEAs) are scarce, such as in hydrologically isolated ombrotrophic bogs, resulting in a $\text{CO}_2:\text{CH}_4$ formation ratio of about 1. However, numerous studies have reported elevated molar $\text{CO}_2:\text{CH}_4$ formation ratios, indicating the presence of a previously unrecognized TEA used in anaerobic respiration – particulate organic matter (POM). We present results from combined field and laboratory studies to assess electron transfer to oxidized POM (POM_{ox}) and its effects on CO_2 and CH_4 formation. Deploying litter mesh bags containing POM_{ox} into anoxic subsurface of three ombrotrophic bogs for one year demonstrated extensive reduction of the buried POM. Subsequent exposure of the reduced POM to air (*i.e.*, O_2) increased its electron accepting capacity, supporting the idea of POM acting as reversible TEA at oxic-anoxic interfaces. In selected laboratory bog soil incubations, we made amendments with POM_{ox} and glucose, which resulted in increases in $\text{CO}_2:\text{CH}_4$ formation ratios of several orders of magnitude. These findings pointed towards anaerobic respiration using POM_{ox} as TEA, thereby suppressing methanogenesis. Altogether, our work provides evidence for POM_{ox} reduction in the field and substantiates the important role of POM as TEA in controlling CH_4 formation in ombrotrophic bogs.

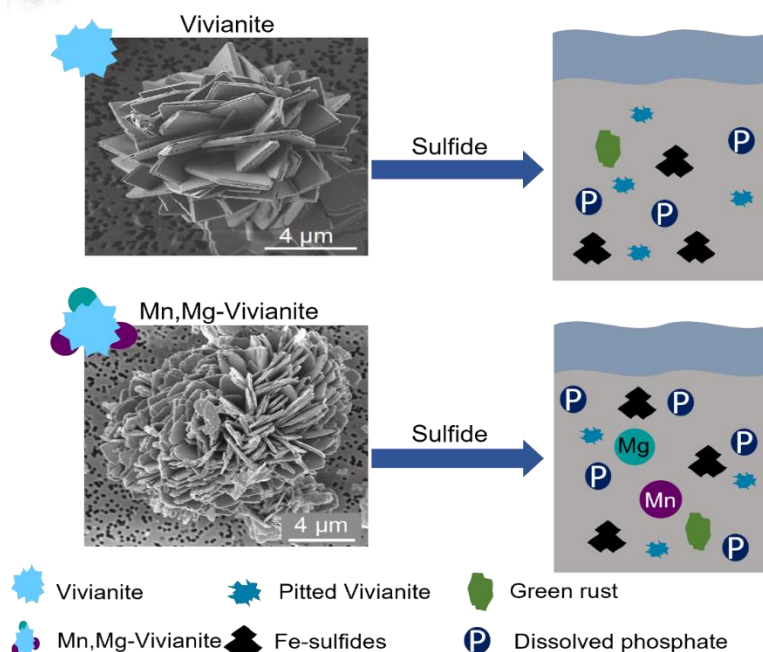




Effect of Mn and Mg substitution on vivianite transformation under sulfidic conditions.

Phosphorus (P) is an important nutrient for primary production in aquatic ecosystems, but excessive concentrations can lead to eutrophication. The chemical form in which P is associated in sediments determines its bioavailability. Under reducing, non-sulfidic conditions, the ferrous phosphate mineral vivianite can be a major P burial phase in coastal sediments. Future changes in salinity may enhance sulfide formation in currently non-sulfidic sediments containing vivianite, leading to thermodynamically unstable conditions for vivianite. Despite the potential future destabilization of vivianite as a P burial sink, vivianite transformation processes under in-situ sulfidic conditions remain unclear. Additionally, it is unknown how commonly observed cation substitution (Mn and Mg) for Fe in vivianite affects the mineral's reactivity and transformation.

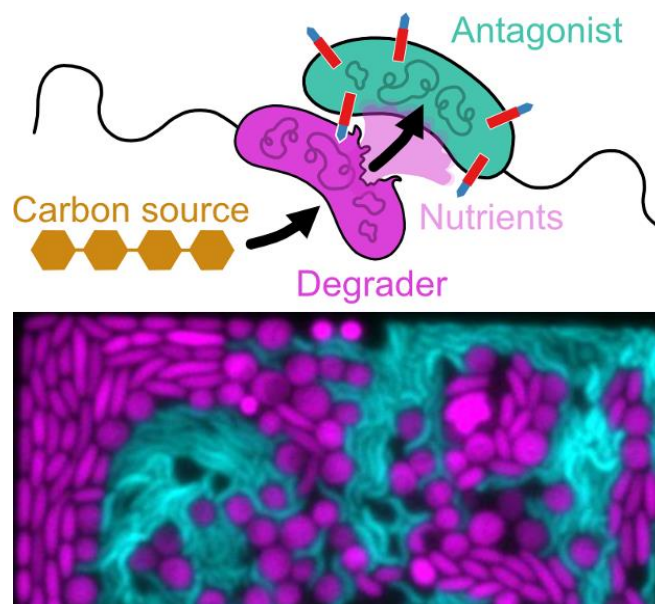
We studied the transformation of Fe-pure and Mn-,Mg-substituted vivianite in two intertidal flats with contrasting sulfide concentrations over eight weeks. Sulfide exposure of vivianite resulted in mineral dissolution, followed by the formation of secondary minerals such as Fe-sulfides. While some of the released elements were retained in secondary phases, substantial amounts were released to the surrounding environment. These results suggest that vivianite containing sediments might become sources of bioavailable P under changing environmental conditions, which has implications for water quality and future coastal management.





The nutritional benefit of killing.

Microbial interactions shape the composition and function of microbial communities with major implications for the ecosystem ecology and biogeochemical cycles. Antagonistic interactions are commonly perceived as means to reduce the growth rate or the cell number of competing community members, however, our understanding of their ecological impact in natural environments remains limited. To address this knowledge gap, we investigate antagonistic interactions mediated by the type VI secretion system (T6SS), a bacteriophage-tail-like nanomachine widespread among Gram-negative bacteria. We study simple marine communities made up of both *Vibrio* spp. antagonists and non-antagonists using microfluidics and time-lapse microscopy. Our findings suggest a novel role of antagonistic interactions in acquiring nutrients from lysing cells in nutrient-limited conditions, while quickly eliminating competitors in nutrient-rich conditions. To understand if nutrient acquisition from antagonized cells is a general principle, we search for genomic adaptations towards this opportunistic predatory lifestyle in T6SS-harboring *Vibrio* spp.. Additionally, we mine global metagenomic and metatranscriptomic samples of natural microbial communities to investigate whether the abundance of T6SS-encoding bacteria and their expression profile in nature support the new role of the T6SS in opportunistic predation. These findings will help develop an understanding of the ecological role of the T6SS in marine ecosystems and contribute to a quantitative understanding of antagonistic interactions in natural environments.



Posters session A

A01 Dominic Eriksson

Nitrogen fixation increases with diazotroph richness in the global ocean.

A02 Lisa Leist

Tracing Ocean circulation in the Subpolar North Atlantic using Artificial Radionuclides.

A03 Nora Bernet

Oxygen Isotope Analysis of Phosphate by ESI-Orbitrap High-Resolution Mass Spectrometry.

A04 Jenny Maner

Chemical toxicity testing with fish cells in the RAINBOWFLOW CHIP impedance biosensor.

A05 Pauline Béziat

Selenium and marine algae – putting a micronutrient in environmental perspective.

A06 Thierry Marti

The underexplored xenobiotic biotransformation potential of the urinary tract microbiota.

A07 Mihai-Ovidiu Degeratu

Investigating chemical toxicity via protein markers in fish cell lines.

A08 Sven Lukas Mosimann

A Cell-Line-Based RNA- and RIBOseq Approach Towards Understanding Chemically Induced Growth Inhibition.

Posters session A

A09 Francesco Parrella

Heteroaggregation between microplastics and algae can accelerate vertical transport affecting biogeochemical cycles.

A10 Urs Hofmann Elizondo

Shelled pteropod response to acidification during temperature extremes in the California Current System.

A11 Johannes Schorr

Closing the gap: Ion chromatography coupled to high-resolution mass spectrometry to trace highly polar anionic substances in groundwater.

A12 Ville Nenonen

Phosphate retention by Fe(III)- and Ca-precipitates formed upon Fe(II)-oxidation in exfiltrating groundwater.

A13 Gatwa Tshinsele

Non-growing bacteria can metabolically interact with and support growth of others.

A14 Silvan Arn

Mulch film biodegradation in soils I: Experimental design and soil and scale effects.

A15 Flora Wille

Mulch film biodegradation in soils II: Fertilization and film particle size effects.

Posters session B

B01 Kevin Kleemann

Adsorption and Transport of biodegradable water-soluble polymers (BWSPs) to soil minerals: Effects of conformation in adsorbed states and polymer structure.

B02 Maya Amacha

The Photochemistry of Thiophenes in Aquatic Environment.

B03 Rachel London

Are Analysis of Alternative Methods Suitable for Poly- and Perfluoroalkyl Substances?

B04 Jessica Bertoli

Developing fish cell-based models for neurotoxicity testing.

B05 Céline Margot

A reactor for production of *Legionella pneumophila*-containing biofilms.

B06 Simon Rath

Achieving Realistic Ozonation Conditions with Low Molecular Weight Compounds as a Surrogate for Dissolved Organic Matter.

B07 Corina Meyer

Abatement of Pharmaceuticals and Their Metabolites in Wastewater Treatment.

B08 Wentao Gong

Paradigm shift to sampling dissolved eDNA and compounds in lakes with Lagrangian approach.

Posters session B

B09 Juliana Oliveira

Tintenstrich communities: a first insight into alpine cyano-lichen metabolites.

B10 Jana Härri

Nitrogen loss processes in the Oxygen Minimum Zones of the Eastern Pacific.

B11 Roman Schefer

Eco-corona formation on plastics: Adsorption of dissolved organic matter to pristine and photochemically weathered polymers.

B12 Annabel Payne

A new compilation of Anthropogenic Radionuclides and Transit Time Distributions in the Canada Basin.

B13 Simin Li

Predictions of Cadmium toxicity and accumulation to soil collembolan by BPNN models.

B14 Natalie Wichmann

Biotransformation of Antimicrobial Peptides by Wastewater Peptidases.

B15 Xuejian Wang

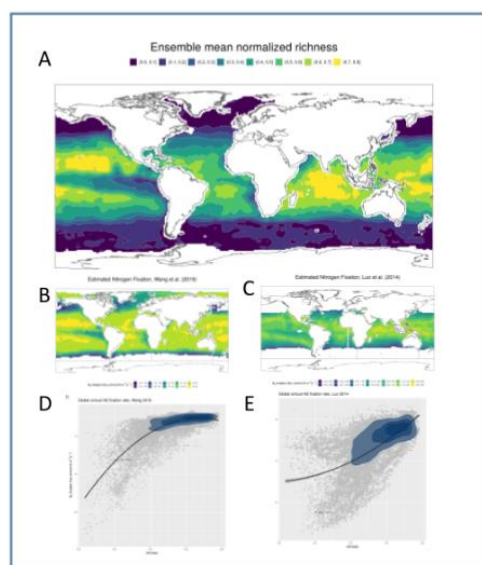
Seasonal patterns of cyanobacterial metabolites and their biotransformation in surface waters.

B16 Morgan Vallières

The Photochemical Role of DOM On The Cycling Of Carbon To The Atmosphere.

Nitrogen fixation increases with diazotroph richness in the global ocean.

Marine diazotrophs convert atmospheric nitrogen gas into bioavailable nitrogen that can fuel up to 50% of the primary productivity in oligotrophic subtropical and tropical seas. Despite their importance, little is known about their global biogeography and diversity since global studies have been hampered by scarce data observations within the marine environment. To analyse the correlation between global richness and nitrogen fixation rates, we integrate -omics and traditional microscopic based observations and make use of Species Distribution Models that have been developed to cope with datasets that suffer from uneven sampling efforts and scarce observations. Global diazotroph richness is generally high in subtropical and tropical marine regions declining polewards with hotspots of diversity found in the Pacific and Indian Ocean. We provide the first global biogeographic pattern of non-cyanobacterial diazotrophs that show increased probability of occurrences within upwelling regions when contrasted to cyanobacterial diazotrophs. Finally, to assess the relationship between global diazotroph richness and ecosystem function, we analysed the correlation between our global richness projections and global nitrogen fixation rates from two separate publications and found a positive relationship between global diazotroph richness and nitrogen fixation rates supporting the resource use efficiency hypothesis.



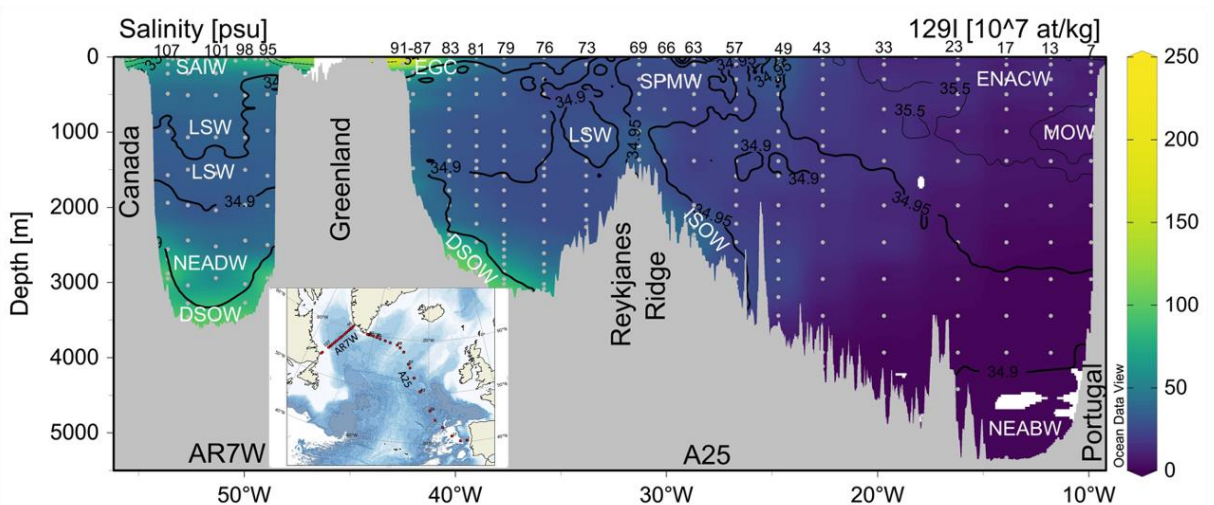
Tracing Ocean circulation in the Subpolar North Atlantic using Artificial Radionuclides.

The subpolar north Atlantic, between Portugal and Greenland, is a key region for deep and intermediate water mass formation and contributes to the lower limb of the Atlantic Meridional Overturning Circulation.

The formation and circulation of water masses, especially the dense overflow and intermediate waters can be studied using the artificial radionuclide tracer pair ^{129}I and ^{236}U , which are mainly released by European nuclear reprocessing plants.

Here we will present the evolution of ^{129}I from 2014 to 2021 and the use of both tracers to study the mixing of different water masses and their formation.

Along the whole transect, the ^{129}I concentration increased significantly from 2014, especially in the dense overflow waters and the Labrador Sea Water. The origin of water masses contributing to the most dominant water masses in the subpolar north Atlantic could partially be resolved using the combination of both artificial radionuclides.

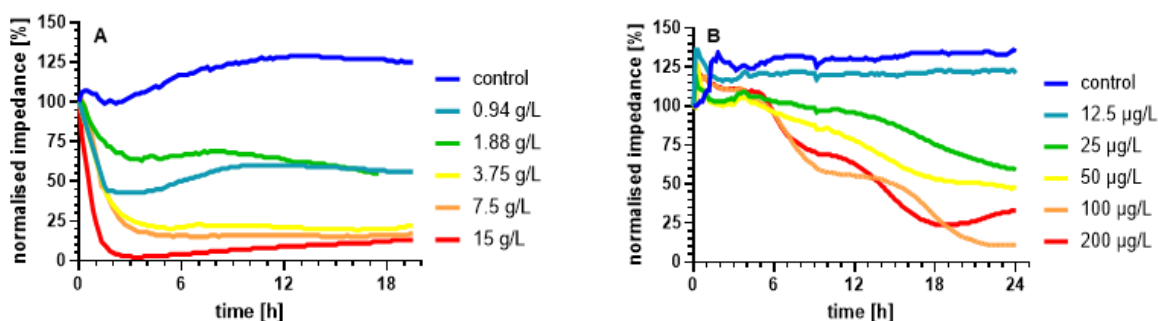


Oxygen Isotope Analysis of Phosphate by ESI-Orbitrap High-Resolution Mass Spectrometry.

Understanding the impact of human activities on the metabolic state of soil and aquatic environments is of paramount importance to implement measures for maintaining ecosystem services and sustainable access to food, water, and energy. Variations of natural abundance oxygen isotope ratios in phosphate provide a new avenue for holistic assessments of metabolic activity in the environmental microbiome given the crucial importance of phosphoryl transfer reactions in fundamental biological processes. Here, we evaluated recently introduced instrumental approaches to oxygen isotope ratio measurements of oxyanions by electrospray ionisation (ESI) Orbitrap high-resolution mass spectrometry. Specifically, we examined precision and accuracy of $^{18}\text{O}/^{16}\text{O}$ ratio measurements in phosphate standards using a Q-Exactive Plus mass spectrometer (Thermo Fisher Scientific, Germany). $^{18}\text{O}/^{16}\text{O}$ ratios were obtained from quantifying signal intensities of two di-hydrogenphosphate isotopologue anions ($\text{H}_2\text{P}^{16}\text{O}_4^-$ and $\text{H}_2\text{P}^{16}\text{O}_3^{18}\text{O}^-$). Standards consisted of a series of eight diluted phosphoric acid solutions with known $\delta^{18}\text{O}$ from -350‰ to $+300\text{‰}$ out of which, five covered the known environmental range between 0‰ and 60‰ . The ESI-Orbitrap approach to $\delta^{18}\text{O}$ in phosphate could potentially simplify sample preparation and thus increase sample throughput, thereby providing the circumstances for in-depth studies of changes in the microbial metabolism in the environment.

Chemical toxicity testing with fish cells in the RAINBOWFLOW CHIP impedance biosensor.

Toxicity to fish is a critical issue in chemical risk assessment, demanding the sacrifice of hundreds of thousands of fish for toxicity testing. Permanent fish cell lines have emerged as a powerful *in vitro* alternative to animal experiments, as they can predict acute toxicity to fish. In the RAINBOWFLOW CHIP project, we use two epithelial cell lines from rainbow trout (*Oncorhynchus mykiss*) to investigate the time- and concentration-dependent effects of chemicals by Electric Cell-substrate Impedance Sensing (ECIS). This is a fast and non-invasive method for cell viability assessment, which can easily be automated. As a consequence, cell viability can be monitored in real-time during chemical exposure. Cells are exposed under flow conditions in a microfluidic setup. The fluid flow creates a shear stress, which is a physiological stimulus to epithelial cells. The use of multi-channel ECIS chips enables the testing of several chemical concentrations in parallel. We show the wide applicability of the system on the basis of model compounds with different physico-chemical properties and toxic modes of action. Our results indicate that the two cell lines give similar results for the same chemicals, while different chemicals show different toxicity profiles over time.

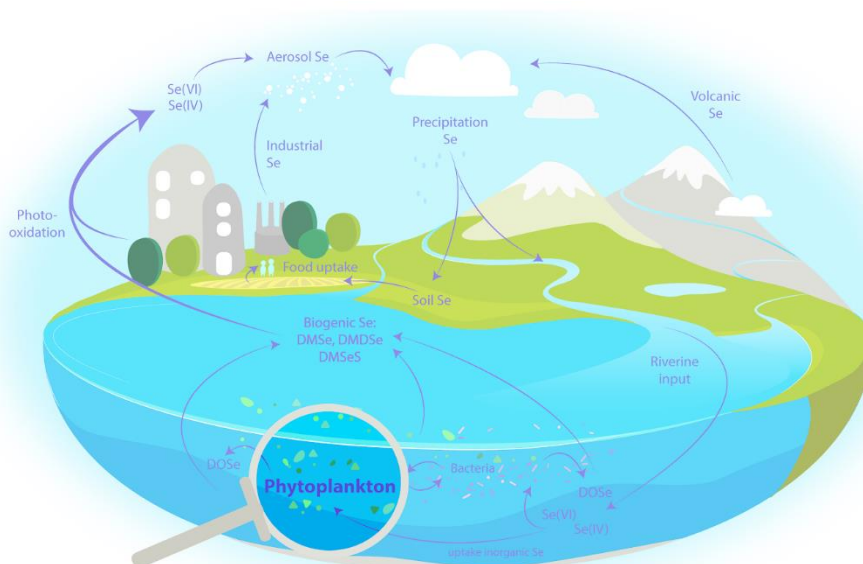


Impedance of intestinal cell line RTgutGC exposed to caffeine (A) and hexachlorophene (B)

Selenium and marine algae – putting a micronutrient in environmental perspective.

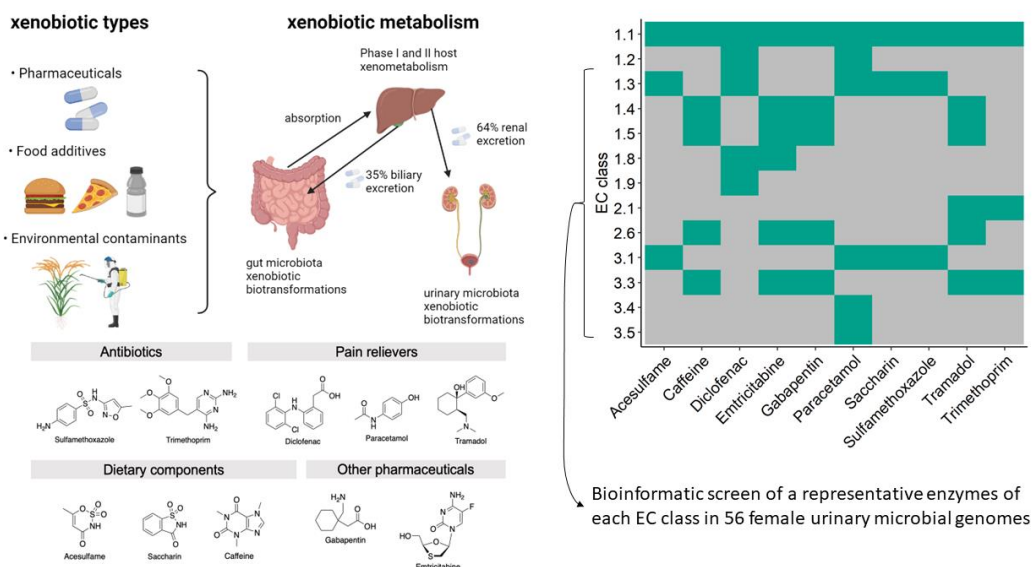
The marine biosphere appears to be a centerpiece in global Se cycling. Environmental correlation analyses suggest marine algae to be responsible for Se volatilization from seawater in the form of dimethylselenide (DMSe). Indeed, we have demonstrated axenic phytoplankton cultures to produce DMSe. However, it remains unclear whether this process occurs in the environment since Se is also an important micronutrient for phytoplankton: using systematic growth essays, we extended previous observations confirming strong obligate Se essentiality in algae. In the ocean, Se is present at trace concentrations and can be depleted down to low pM levels during phytoplankton blooms – levels that might be limiting growth. Why would marine algae remove Se from seawater through biovolatilisation if they need it as a micronutrient?

Here we present how we approach this conundrum from different analytical angles. First, we quantify how much Se is required by different algae species and how this demand changes under changing growth conditions. We then investigate what kinds of metabolites Se gets integrated in within phytoplankton cells and lastly, we employ marine algae – bacteria co-cultures to place our findings into a better environmental context, investigating how algae relate to marine bacteria in the production of volatile Se.



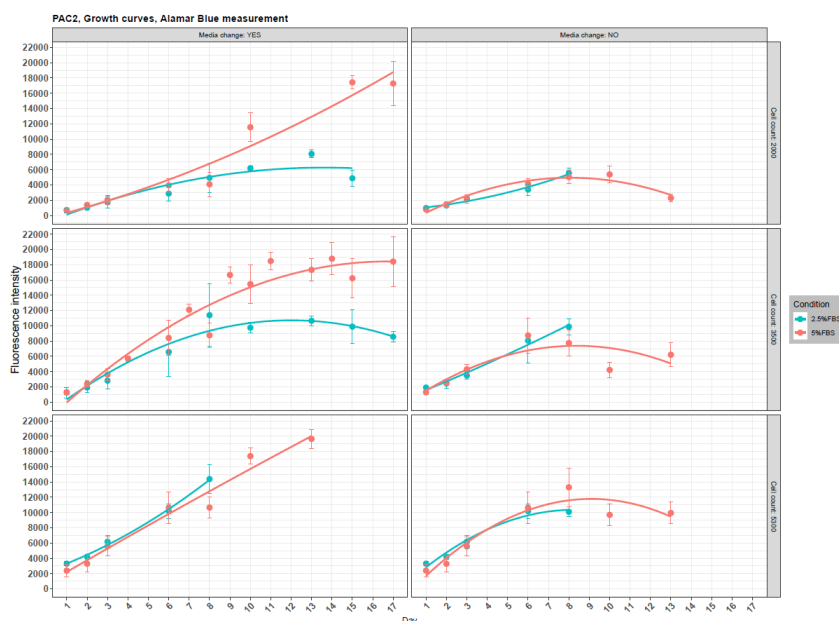
The underexplored xenobiotic biotransformation potential of the urinary tract microbiota.

Microbes are talented chemists capable of transforming xenobiotics within the human body. Most research on microbial xenometabolism has focused on the gut microbiota although the majority of xenobiotics are primarily excreted in urine. Colonic bacteria thus only come in contact with many xenobiotic compounds in trace amounts relative to the exposure of microbial communities in the urinary tract. While microbial biomass and residence time in the gut is higher, xenobiotic biotransformations in the bladder have the potential to affect antibiotic resistance, urinary tract infections, and diet-drug-microbe-host interactions. However, we have limited knowledge of xenobiotic-transforming enzymes encoded in urinary microbiomes. We compared the community composition and environmental differences between the gastrointestinal and urinary tracts, with a focus on its relevance for xenobiotic biocatalysis. We used a comparative genome mining approach to profile the distribution of xenobiotic-degrading enzyme classes encoded in urinary tract bacteria. Our analysis revealed a discontinuous enzyme class distribution and high conservation of amidase homologs in paracetamol and artificial sweetener biotransformation pathways, pinpointing new candidates for biochemical characterization. Overall, we highlight the overlooked biocatalytic potential of urinary tract bacteria to gain insights into how the human microbiota responds and adapts to xenobiotic inputs.



Investigating chemical toxicity via protein markers in fish cell lines.

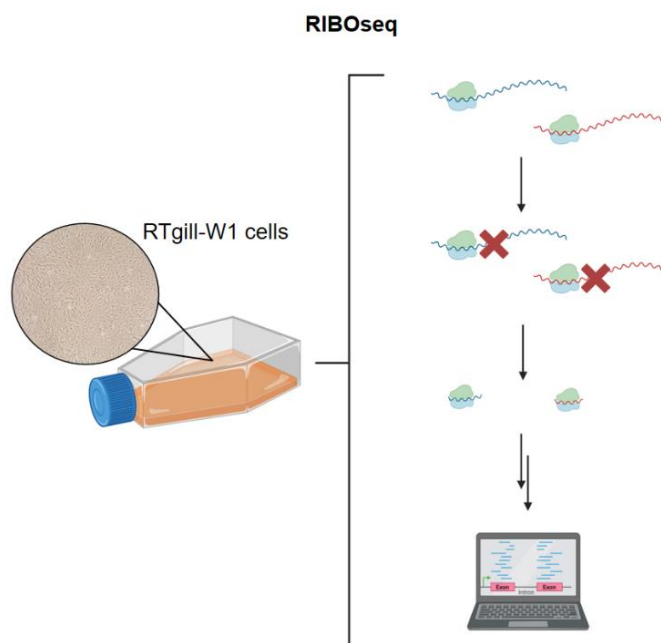
Chemical toxicity testing of aquatic systems often requires large number of fish and ample resources for its completion, which raises ethical and socio-economical concerns. Alternative methods, such as cell line-based approaches, might offer a solution to this problem. Fish cell lines (such as those derived from zebrafish and rainbow trout) can be grouped in the frame of a fish invitrome and answer the need for alternative methods for toxicity testing in fish. My project aims to study different mechanisms of chemical toxicity, such as oxidative stress, heat shock stress and endoplasmatic reticular stress, by measuring protein markers via global and targeted proteomics. As a first step towards achieving this, zebrafish (*Danio rerio*) embryonic cell line, PAC2, was characterised for its growth pattern in 96-well microplates. Cell viability measurements were taken for PAC2 cells exposed to different cell culturing parameters (FBS concentrations; cell seeding densities; culture media change) at different time points post-seeding. Results showed that, for an optimal growth, the cell culturing parameters were 5%FBS, 3500 cells/well seeding density and weekly media change. This project contributes to advancing animal-free prediction of chemical toxicity via the expansion of the fish invitrome.



Zebrafish PAC2 cells were characterized for their growth pattern in 96-well microplate format according to different cell culturing parameters: Fetal Bovine Serum (FBS) concentrations: 2.5% and 5%; cell seeding densities: 2000, 3500 and 5300 cells/well; culture media change: YES or NO. Fluorescence intensity was measured with Alamar Blue cellular assay. 28

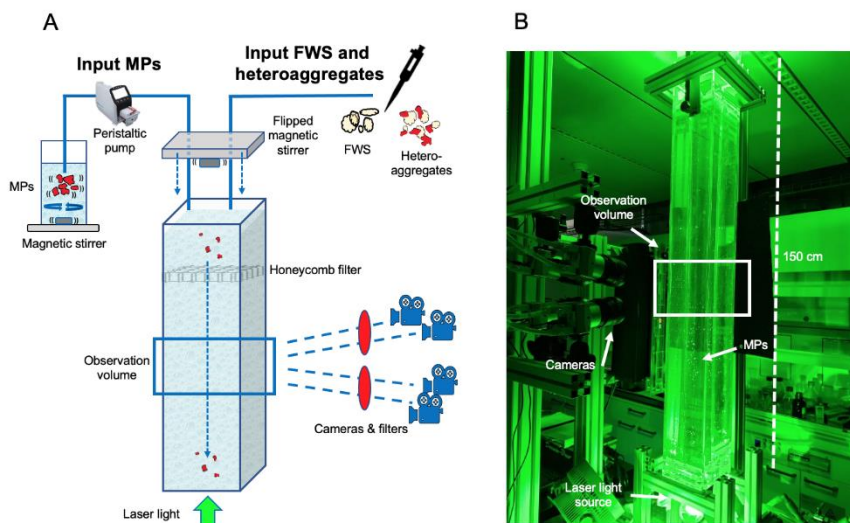
A Cell-Line-Based RNA- and RIBOseq Approach Towards Understanding Chemically Induced Growth Inhibition.

Fish are affected by various environmental pollutants, which can lead to both acute and chronic adverse outcomes. However, chronic effects appear to be more prevalent and amongst others include a reduction in growth. Yet, regulatory studies assessing this endpoint are not only under ethical scrutiny, but also resource and time consuming. Therefore, alternatives, such as cell line-based assays are required. While exploring the potential of the gill-derived, epithelia-like rainbow trout cell line, RTgill-W1, researchers from our group not only showed a clear correlation between reduced cell proliferation and fish growth, but also found that highly different chemicals can lead to the same outcome, namely a reduction in cell proliferation and thus fish growth. My PhD project aims at identifying the points at which the initially highly different molecular pathways converge and cause a reduction in cell proliferation. For this purpose, RTgill-W1 cells have been exposed to six chemicals and dose-response curves have been obtained at different time points. Preliminary results suggest that most of the observed effects already occur at early time points. In a next step, RNA- and RIBOseq experiments will be conducted to identify the different molecular pathways triggered by these chemicals and their points of convergence.



Heteroaggregation between microplastics and algae can accelerate vertical transport affecting biogeochemical cycles.

Understanding the processes which drive microplastics (MPs) distribution and fate in aqueous environments is limited, especially in consideration of how heteroaggregation with natural particles affect settling dynamics. Freshwater snow (FWS), a mixture of algae and natural particles, is responsible for most of the flux of organic matter from the water surface to the sediments. Knowing how MPs and FWS interact and influence their respective settling rates can support both MPs fate modelling efforts and assessing their ecological impacts with respect to FWS settling rates and nutrient cycling. Here we used a laser-illuminated plexiglass column (Figure1) equipped with a stereoscopic camera system to track the settling velocities of particles in three tests: 1) MPs of various size, density and morphology, 2) FWS flocks and 3) MPs-FWS heteroaggregates. For each experimental set, thousands of particles were tracked over a series of image sequences. Heteroaggregates with dense MPs settled significantly faster than either MPs or FWS alone, except in the case of heteroaggregates with MPs fibers. This may impact biogeochemical cycles by changing the flux of carbon, nitrogen, and phosphorus contained in FWS to the sediment, with possible far-reaching implications on productivity throughout the water column.



A: Schematic of experimental design with the different input systems according to the particle considered and camera arrays calibrated on the observation volume. B: image of laboratory set-up, during a test run of MPs.

Shelled pteropod response to acidification during temperature extremes in the California Current System.

Migratory shelled pteropods, are naturally exposed to higher temperatures and acidity near the surface and at depth during their diel vertical migration, respectively. However, the long-term warming and acidification trends due to anthropogenic emissions have already increased the exposure frequency and magnitude to such harmful conditions. Thus, shelled pteropods will likely encounter multiple stressors with a higher frequency in the future. In this study, we assess the effect of multiple stressors on shelled pteropods of the CalCS based on an individual-based model with life-stage specific responses to environmental conditions. The effects were assessed for the period between 2011 and 2019, since this period includes the long-lasting marine heatwave 'the Blob'. We find that the shell dissolution is roughly halved during the heatwave, but the combined exposure to acidity and high temperatures nearly double the simulated pteropod mortality. However, the contribution of these stressors to the dissolution and mortality depend on the life-stage of the pteropod during exposure, suggesting that the life-cycle dynamics of shelled pteropods play a crucial role in determining their response to multiple stressors

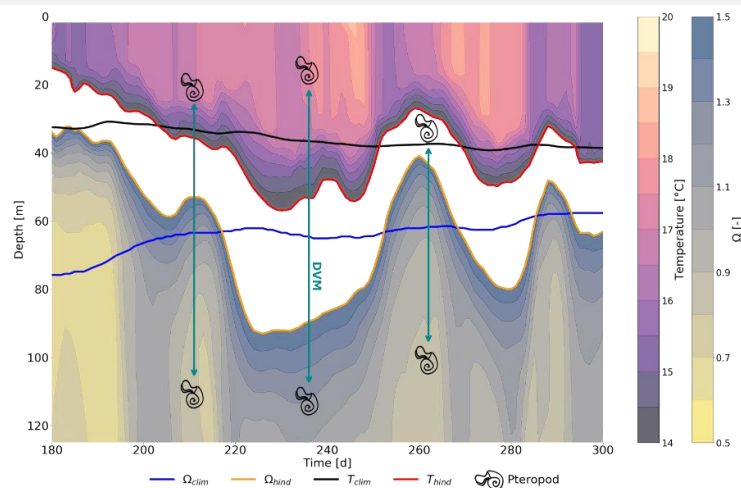
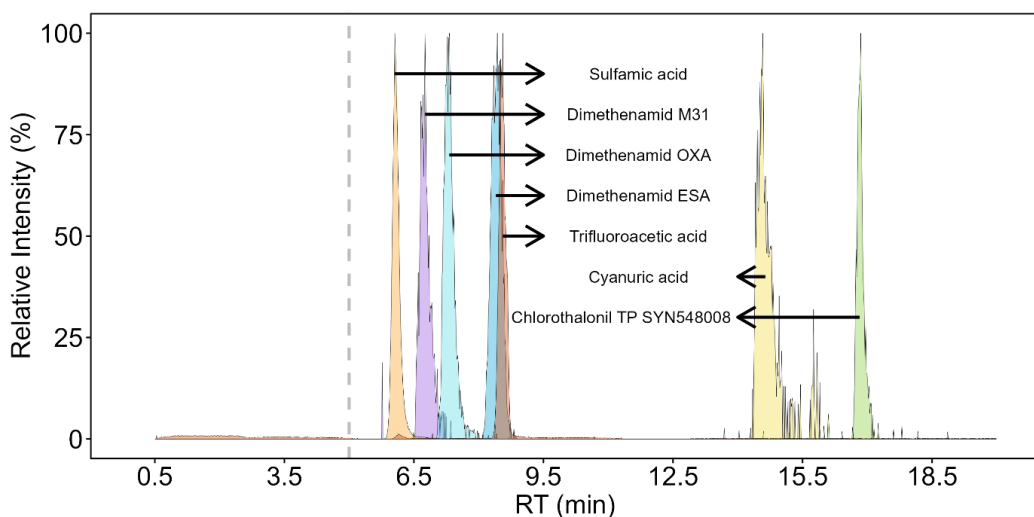


Figure 1: Acidification and warming events encountered by modeled pteropods during diel vertical migration (cyan) for the upper 125 m at 35°N and -124°E from day 180 to 300. The solid lines on the lower half show the $\Omega = 1.5$ horizon for the hindcast simulation (Ω_{hind} ; orange) and for the daily climatology over the hindcast simulation (blue). The solid lines on the upper half show the temperature horizon $T = 14$ °C for the hindcast simulation (T_{hind} ; red) and for the daily climatology over the hindcast simulation (black). The background color below Ω_{hind} shows the Ω of the hindcast simulation. The background color above T_{hind} shows the temperature of the hindcast simulation. Regions with harmful conditions are all locations below the orange line and above the red line.

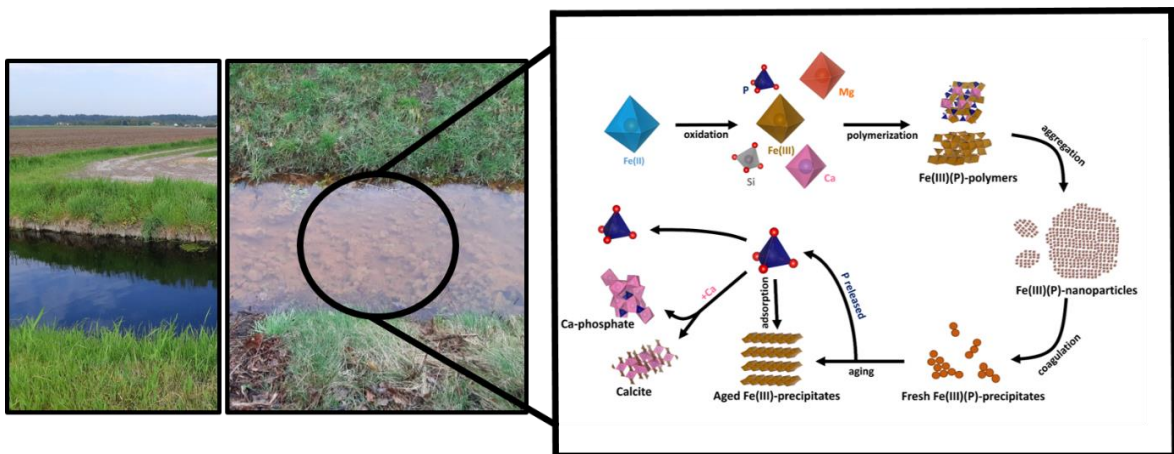
Closing the gap: Ion chromatography coupled to high-resolution mass spectrometry to trace highly polar anionic substances in groundwater.

Polar, mobile and toxic (PMT) and very polar and very mobile (vPvM) substances pose a threat to the water cycle, but are often not covered in conventional environmental monitoring programs. Within this realm of substances, one compound class of concern are pesticides and their transformation products as they are deliberately introduced into the environment. To detect very polar anionic substances including many pesticide transformation products with log DOW values ranging between -7.4 and 2.2 an ion chromatography high resolution mass spectrometry method was developed in this study. Since inorganic anions, such as chloride and sulfate, interfere with the analysis of organic species, their removal via precipitation with Ag/Ba/H cartridges was assessed. To improve LOQs, vacuum assisted evaporative concentration (VEC) was evaluated. By using VEC and removing inorganic salt ions, the median LOQ improved from 100 ng/L in Evian water without sample treatment to 10 ng/L after enrichment and 32 ng/L in karst groundwater. Using this method, 12 out of 66 substances covered by the final method were found in karst groundwater in concentrations of up to 5600 ng/L and seven exceeded 100 ng/L. To the best of our knowledge, the dimethenamid TP M31 and chlorothalonil TP SYN548008 were detected for the first time in karst groundwater samples. The coupling to an orbitrap mass spectrometer also allows for non-target screening and hence, this method presents a powerful tool to tackle PMT/vPvM substances.



Phosphate retention by Fe(III)- and Ca-precipitates formed upon Fe(II)-oxidation in exfiltrating groundwater.

Phosphorus is an essential nutrient, but excessive inputs into surface waters may lead to the eutrophication and impairment of aquatic ecosystems. The biogeochemical cycling of phosphorus is coupled to the redox cycling of Fe. The oxidation of dissolved Fe(II) in natural waters leads to the formation of Fe(III)-precipitates with a high sorption capacity for phosphate (P). Fresh Fe(III)-precipitates are metastable and can transform into more stable phases over time, which may lead to the release of initially bound P. The formation and transformation of Fe(III)-precipitates in natural waters is strongly affected by other solutes (Ca, Mg, P, Si) that interfere with Fe(III) precipitation and polymerization, and thereby also affect P binding. Furthermore, in the presence of Ca, repartitioning of P released from Fe(III)-precipitates into Ca-carbonates or –phosphates, could attenuate P release. In this project, our focus was on the interdependent effects of Ca, Mg, Si, and P on these coupled processes in laboratory experiments under conditions representative for natural waters. We used a selection of spectroscopic and microscopic techniques to provide new insights into the molecular- and nanometer-scale processes that control the fate of P in environmental systems.



A schematic representation of Fe(III)- and Ca-precipitate dynamics with phosphate in fresh and aging suspensions in agricultural settings.

Non-growing bacteria can metabolically interact with and support growth of others.

Microbial communities play a determining role in the processes of virtually all ecosystems they colonize, from earth's geochemical cycles to human health. This project aims at gaining an integrative and quantitative understanding of a novel synthetic community of two members of the gut microbiota: *Escherichia coli* and the probiotic lactic acid bacterium *Lactobacillus plantarum*. We want to understand how spatial arrangement determines the molecular networks between two bacteria and how these could scale up to shape the function and organization of a community using live-cell imaging of co-cultures growing in a microfluidic chip.

To that end, I first managed to establish a cross-feeding community between *E. coli* and *L. plantarum* in a minimal medium with sucrose as a carbon source which *E. coli* is not able to metabolize and depends on *L. plantarum* digestion of it. In return, *E. coli* excretes amino acids and vitamins not supplemented in the medium for which *L. plantarum* is auxotrophic. Surprisingly, when switching to this medium, *L. plantarum* growth stops while *E. coli* maintains its division rate, suggesting that *L. plantarum* is able to cross-feed and support *E. coli* growth while not dividing itself. This phenomenon could provide a new layer of robustness in cross-feeding communities during shifts to nutrient-poor environments.

Mulch film biodegradation in soils I: Experimental design and soil and scale effects.

Conventional polyethylene mulch films accumulate in soils if incompletely removed after use. Biodegradable mulch films – which are completely microbially degraded in soils - offer an alternative and help overcome plastic pollution. European certification of biodegradable mulch films relies on laboratory soil incubations at 20-28°C. These laboratory incubations have, however, been criticized for not being representative of incubation conditions in the field. In this work, we address this criticism by systematically assessing the biodegradation dynamics of two commercially available biodegradable mulch films in three soils across three incubation scales: the laboratory, greenhouse and in situ in the field. In this first contribution of two, we highlight the analytics developed to quantify mulch film biodegradation in soils and present the experimental design. Biodegradation rates of the two commercial films decrease from the lab to the greenhouse and the field. In the latter, biodegradation of the mulch films remains incomplete over 2 years. Yet, incomplete biodegradation is also observed for an accepted biodegradable reference polymer, demonstrating that soil incubation conditions are critical. Besides the effect of incubation scales, biodegradation dynamics differ between the three tested soils. This work implies that both soil to soil variations and incubation conditions affect mulch film biodegradation dynamics.

Mulch film biodegradation in soils II: Fertilization and film particle size effects.

Biodegradable mulch films are considered viable substitutes for conventional mulch films to overcome plastic pollution in soils. Yet, fundamental aspects of mulch film biodegradation remain poorly understood. In our first contribution, we have shown that the biodegradation of two biodegradable mulch films varies between soils and incubation scales (lab, greenhouse, field) (see Silvan Arn). This contribution extends on this by systematically assessing the effects of soil fertilization and form in which mulch film material is added to soil (i.e., intact film versus powdered film). It has been speculated that fertilization enhances biodegradation in case of nutrient limitation. Similarly, it has been proposed that powdered mulch film - as used in biodegradation tests for certification - may show enhanced biodegradation rates due to higher specific surface area. Our results show that fertilization has little effect on biodegradation in both laboratory and greenhouse incubations, suggesting that biodegradation in these systems is not nutrient limited. Yet, in the field, fertilization seems to enhance biodegradation after 1.5 years of incubation, possibly indicating nutrient limitation. Our results show similar biodegradation dynamics of films and powders, suggesting that the form in which the mulch film is added to soil is not a key factor determining biodegradation.

Adsorption and Transport of biodegradable water-soluble polymers (BWSPs) to soil minerals: Effects of conformation in adsorbed states and polymer structure.

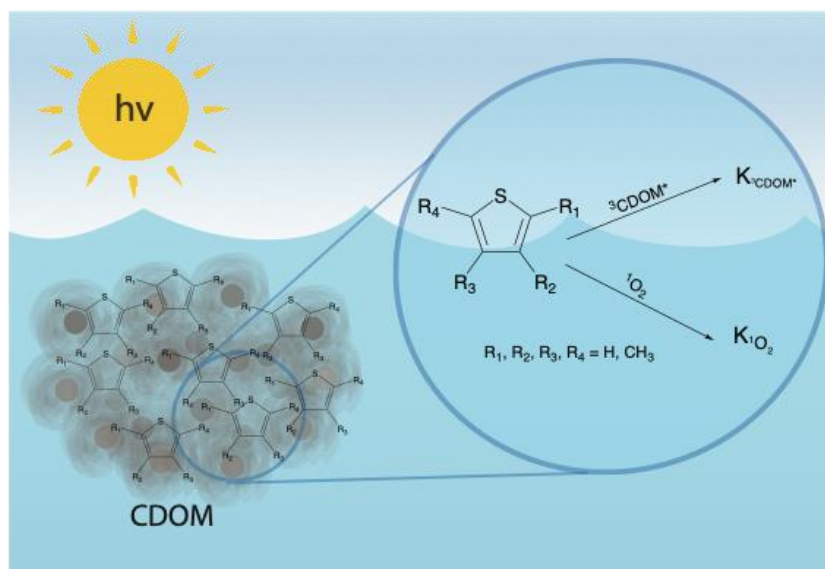
One promising solution to overcome WSP accumulation and potentially associated ecological risks is to replace conventional with biodegradable, water-soluble polymers (BWSPs). Our research focuses on the fate of water-soluble polymers in soils. More specifically, this contribution provides a systematic assessment adsorption of candidate BWSPs to the surfaces of silica and iron-oxides, two minerals common to soils. We assess adsorption of a chemically diverse set of six water-soluble polymers that vary in charge and polarity characteristics. The effects of solution pH and ionic strength (IS) on adsorption to silica were studied using both batch solution depletion experiments and surface adsorption techniques, including quartz crystal microbalance with dissipation monitoring and optical waveguide lightmode spectroscopy. Polymer transport through sand- and iron oxide-coated sand columns was determined. Besides electrostatic interactions between charged polymers and the charged mineral surfaces, polymer conformations in the adsorbed states and hydrogen bonding between the polymer and the mineral controlled the extents of polymer adsorption and, therefore, their transport in soil columns. The implications of the findings for the fate of BWSPs in soils will be highlighted.

The Photochemistry of Thiophenes in Aquatic Environment.

Thiophenes are an important class of sulfur containing heteroatomic compounds. They make up a significant portion of organosulfur containing compounds found in petroleum and other products derived from fossil fuels. Thiophenes have also gained interest in medicine, in which they possess a wide range of therapeutic properties with diverse applications.

Oil spills and pharmaceutical waste are major pathways through which thiophenes are released into the aquatic environment. Several studies have shown that the metabolism of thiophene-containing substrates lead to toxic products. On the other hand, there is lack of fundamental understanding of the thiophene photoreactivity in aquatic systems.

In this study, we investigated the photoreactivity of model thiophenes with different number and position of alkyl groups. This was done in the presence of model and natural sensitizers, namely chromophoric dissolved organic matter (CDOM), the light absorbing fraction of naturally occurring organic molecules in aquatic systems. The photoreactivity of thiophenes with reactive intermediates produced from CDOM (such as $^3\text{CDOM}^*$ and $^1\text{O}_2$), its efficiency, mechanism and the effect of alkyl substitutions have been investigated and will be discussed in detail. These results are important for evaluating the environmental fate of an understudied but important class of organosulfur containing compounds.

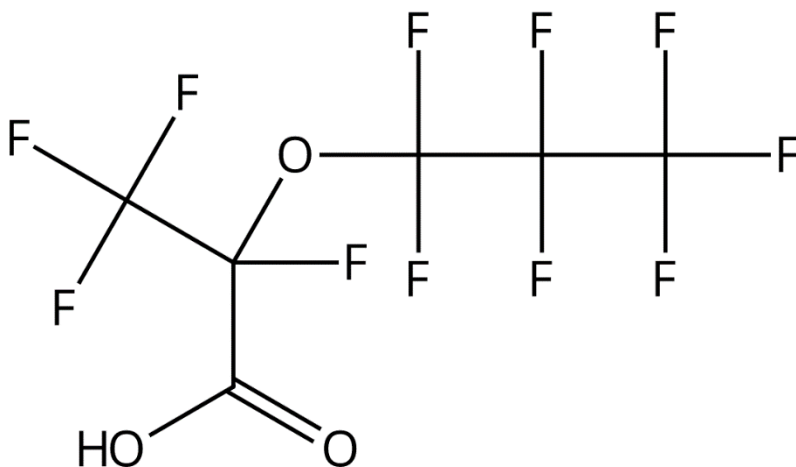


Are Analysis of Alternative Methods Suitable for Poly- and Perfluoroalkyl Substances?

Thousands of Poly- and Perfluoroalkyl Substances (PFAS) are to be restricted in the EU, due to concerns about their impact on human health and the environment. Governments and businesses are seeking alternatives, but are current analysis of alternatives frameworks sufficient to minimize the risk of regrettable substitution?

Current hazard assessment methods, used within analysis of alternatives frameworks, were investigated. Hypothetical substance datasets and real substance datasets, from case studies in the scientific literature, were used to investigate the strengths and limitations of these methods.

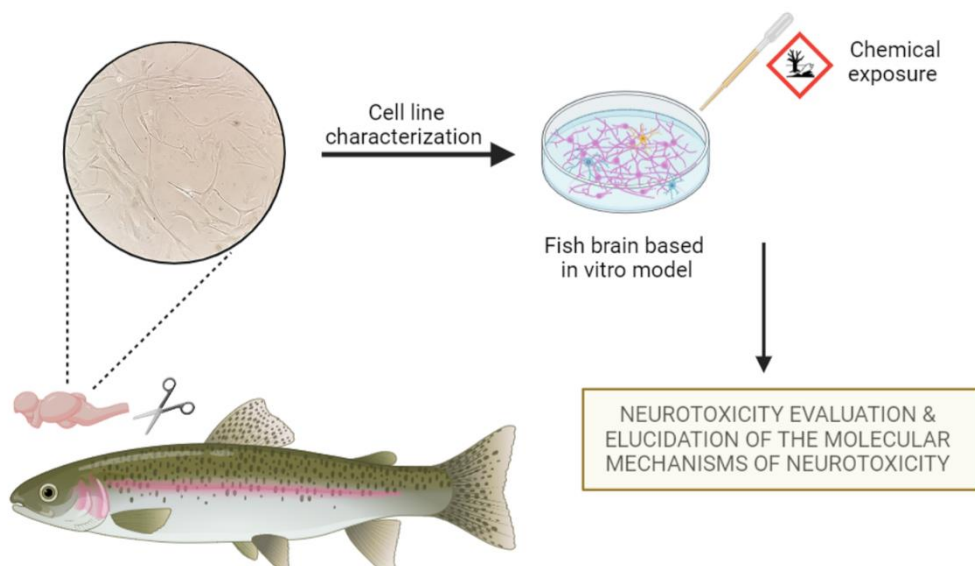
The investigated methods showed considerable flexibility and there is also overlap between them. However, the ability to determine the acceptability of an alternative is not intrinsic to any method. Decision makers need to be aware of the decision rules and parameter settings that govern the application of these methods. Without appropriate awareness of decision rules to be employed as well as settings of method parameters, this flexibility can lead to unacceptable alternatives being erroneously categorised as acceptable. This poster concludes with recommendations as to the appropriate parameter settings to be used in these methods when they are applied to the analysis of chemical alternatives, and the analysis of chemical alternatives to PFAS in particular.



Developing fish cell-based models for neurotoxicity testing.

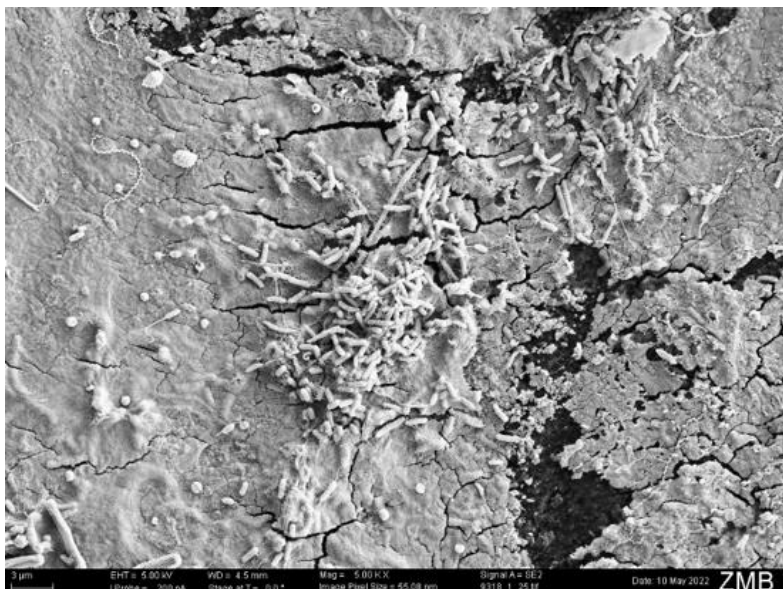
Chemicals released in the environment can affect the neurophysiology of fish and impair their chances of survival. For this reason, the risk assessment of potentially neurotoxic substances is an important factor to ensure the safeguard of aquatic organism. Current guidelines for the ecotoxicological evaluation of chemicals largely depend on animal experiments, which are time consuming and ethically questionable, and allow a limited understanding of the molecular mechanisms underlying the toxicants' action. In vitro technologies represent an excellent alternative for the hazard identification of anthropogenic substances.

This project aims is to develop fish cell-based models for neurotoxicity testing in order to advance our understanding of the mechanisms of neurotoxicity and explore the potential of animal-free alternative tests. For this purpose, we will explore two different test systems: an uncharacterized brain cell line isolated from rainbow trout (*Oncorhynchus mykiss*) and zebrafish (*Danio rerio*) primary embryonic cultures. Initially, we will investigate the proliferative, morphological and functional features of these cells to explore their potential for the neurotoxicity assessment of chemicals and to identify specific neurotoxicity markers. Secondly, we will develop fish brain based in vitro assays for rapid and high-throughput testing of chemicals with a focus on insecticides.



A reactor for production of *Legionella pneumophila*-containing biofilms.

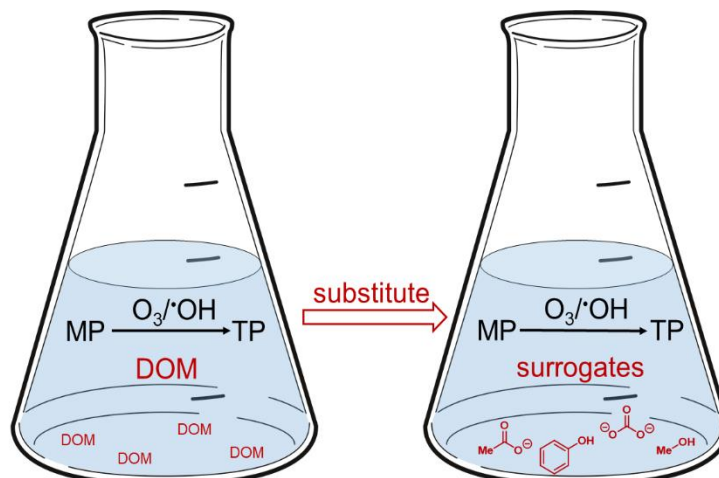
Growth of the pathogen *L. pneumophila* in buildings is affected by environmental factors, such as temperature and the overall drinking water microbiome. The complexity and variability in real building plumbing systems makes it challenging to untangle and quantify the importance of individual environmental factors on *L. pneumophila* growth. To overcome this, we developed a reactor that allows the production of biofilms on ethylene propylene diene monomer (EPDM) pieces naturally colonized by *Legionella* as well as an indigenous bacterial community. Here we report on spatial and temporal heterogeneity in *Legionella* concentrations and overall microbial community in the biofilms during commissioning of the reactor. Culture-based quantification as well as ddPCR show that *L. pneumophila* established quickly in the biofilms reaching a concentration between $1 - 3 \times 10^3$ MPN/cm². The total cell concentration (TCC) on the coupons remained stable at $1 - 5 \times 10^6$ cells per cm² during the 8-weeks commissioning period, with *L. pneumophila* representing around 0.03% of the total cell count. The reactor still successfully and reproducibly produces biofilms containing high concentrations of *L. pneumophila* after more than 10 months of operation, and the biofilms can be used for bench-scale experiments.



SEM image of the grown biofilm.

Achieving Realistic Ozonation Conditions with Low Molecular Weight Compounds as a Surrogate for Dissolved Organic Matter.

Ozone is widely used as a disinfectant and oxidant for the abatement of micropollutants (MPs). The broad oxidation capability of ozonation results from the formation of hydroxyl radicals ($\cdot\text{OH}$) which react with most organic compounds with second-order rate constants near diffusion-control. For the abatement of MPs and the formation of transformation products (TPs) during ozonation it is thus important to investigate both oxidants. To study the formation of TPs from MPs during ozonation and account for both oxidants, realistic ozonation conditions are crucial, however, using DOM has constraints for analytical methods. To overcome this, a tool was developed that can mimic realistic ozonation conditions with low molecular weight scavenging compounds. Scavenger concentrations required to mimic real water samples were estimated. By this system, water matrices for different types of water, such as Lake Zurich water, IOD, $\cdot\text{OH}$ yield in the initial phase of ozonation, as well as the ozone decay rate and $\cdot\text{OH}$ exposure in the second phase matched well with the real water systems. It has been demonstrated that the degradation of MPs and the formation of TPs, such as for bezafibrate and atrazine, were in excellent agreement between the synthetic and real water. For bromate formation similar kinetics and extents were observed. A difference in bromate yield of 14% between secondary wastewater effluent and synthetic water is remarkable, considering the high sensitivity of bromate formation on the interplay of ozone and hydroxyl radicals. In essence, this study developed a tool to mimic realistic ozonation conditions which can be used to identify unknown TPs of MPs considering both oxidants, ozone and hydroxyl radicals, without the constraints of using DOM, which may hinder TP identification.



Abatement of Pharmaceuticals and Their Metabolites in Wastewater Treatment.

Humans are exposed to a multitude of chemical compounds such as pharmaceuticals, which are upon intake often metabolized in order to increase polarity and facilitate their excretion. Many human metabolites arrive at wastewater treatment plants (WWTPs) in higher amounts compared to their parents and are in some cases known to have higher toxicity. Therefore, this study aims the comparison in abatement between parents and respective metabolites in the three treatment plants Altenrhein, Neugut and Werdhölzli. Samples were collected during five consecutive workdays in February/March 2022 at the influent, after primary and secondary clarifier, after ozonation and at the effluent as flow-proportional 24-hour composite samples. Online-SPE-LC-ESI-HRMS/MS in combination with target screening of 188 parent pharmaceuticals and 86 metabolites, previously prioritized based on their consumption amounts in Switzerland and reference standard availability, was applied. Overall, 144 parents and 72 metabolites were detected in the samples. Analysis of parent-metabolite pairs revealed a generally better abatement of metabolites in activated sludge compared to the parents. For the tertiary treatment, no general trend was visible. Additional suspect screening will be performed to identify more pharmaceutical metabolites.

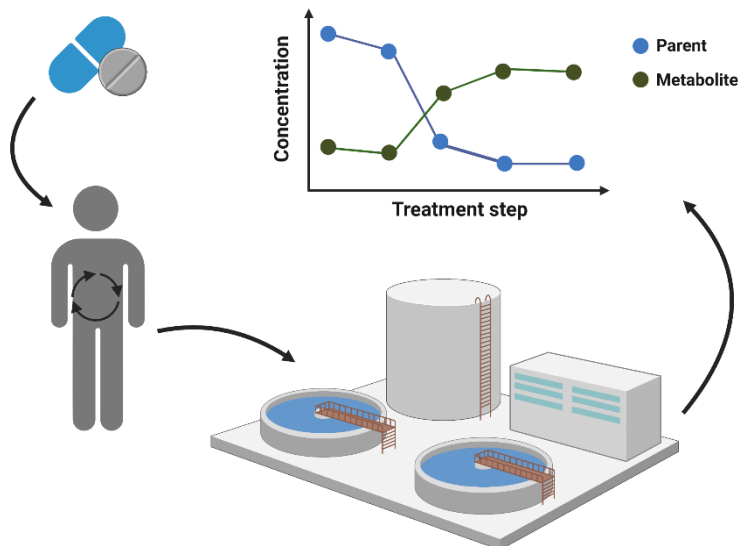
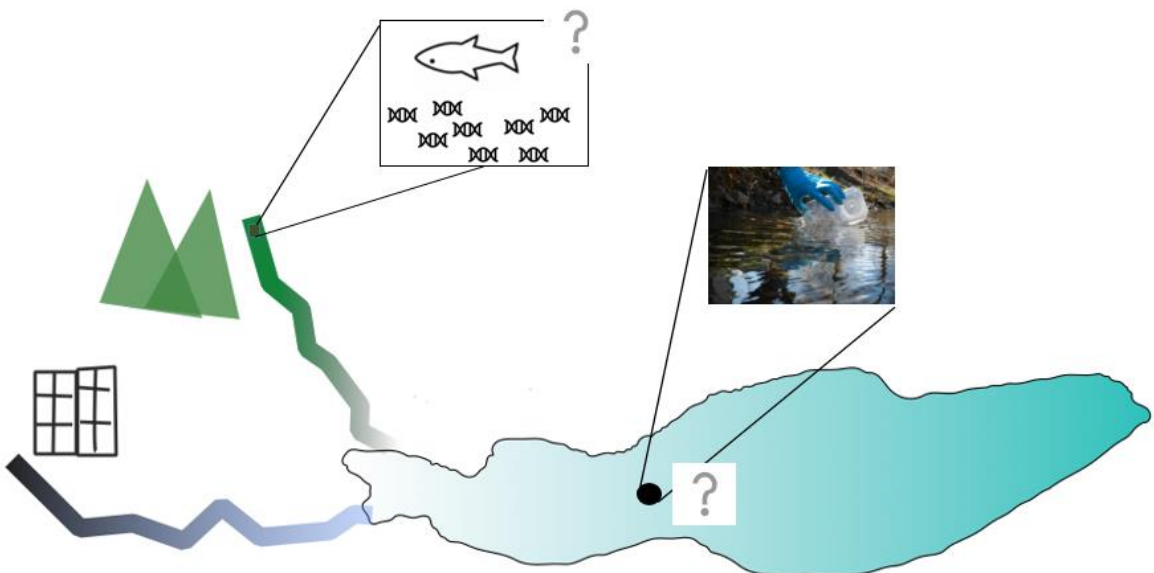


Illustration of the human metabolism of parent pharmaceutical compounds to metabolites, their excretion, entrance into the WWTP and their different abatement during the treatment steps.

Paradigm shift to sampling dissolved eDNA and compounds in lakes with Lagrangian approach.

Are lakes accumulating biodiversity information from the catchment in the form of environmental DNA? This question is today being addressed by ecologists through many experiments conducted to understand the eDNA decay rate in water under different conditions (temperature, pH, salinity, light and so on). Yet, the transport and mixing in lakes is barely investigated. Here we propose to focus on the transport and mixing of eDNA and ultimately address the following questions: What is the best location and depth to monitor eDNA (for biodiversity purposes) in lakes? What's the physical connectivity between the watershed and sampling point with seasonal variation? What is the footprint of measured eDNA at a given location?



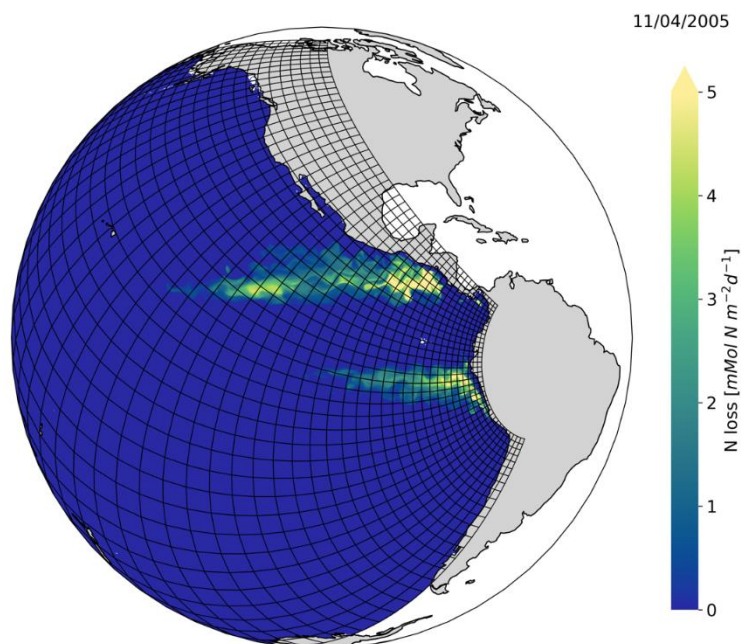
Tintenstrich communities: a first insight into alpine cyano-lichen metabolites.

Subaerial and often dark-colored biofilms, termed Tintenstrich communities ("ink-lines", TCs) extend on rock surfaces in semi-aquatic environments. TCs are widely distributed in high mountain areas, including large parts of the Alpine region. They are predominantly composed of free-living cyanobacteria and associated with lichen-forming fungi, i.e., cyano-lichens. Cyanotoxins pose a major concern for environmental and public health and the World Health Organization defined limits for cyanotoxins in drinking water and recreational water quality guidelines. However, many questions remain unsettled about their role at the soil-water interface including TCs, and the occurrence of cyanotoxins in the Swiss Alps is currently unknown. Therefore, we aim at determining the first insights into the cyanobacterial metabolites of the TCs. Methanolic extracts of TCs biomass that tested positive for cyanotoxin-producing genes was analysed for cyanotoxins by online-SPE-LC-MS/MS. A molecular networking analysis and suspect-screening against CyanoMetDB, a database of known cyanobacterial metabolites was used to annotate tentative candidates in the TC samples. From 209 TC field samples, 85% showed presence of cyanobacteria (16S rRNA), 45.45% showed toxin-encoding genes (PCR), and the first metabolite results demonstrate that toxins are indeed produced in the cyano-lichen TCs in Swiss Alpine regions.



Nitrogen loss processes in the Oxygen Minimum Zones of the Eastern Pacific.

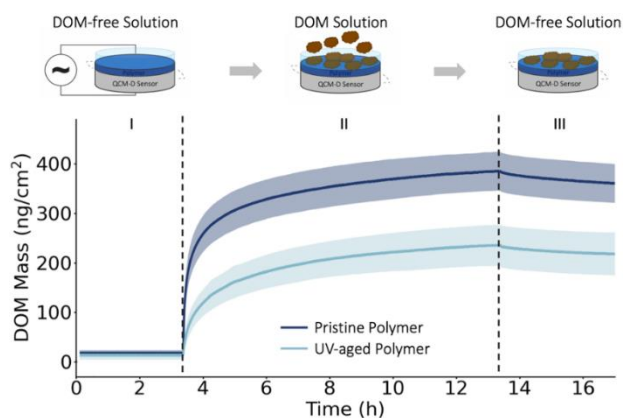
The marine nitrogen inventory is a main control on primary productivity, impacting Earth's climate through its coupling to the carbon cycle (Gruber, 2008). The loss of nitrogen only occurs in the near or total absence of oxygen and is driven by denitrification and anammox (Voss et al., 2013). Using a Regional Ocean Modelling System (ROMS) coupled to a Biogeochemical Elemental Cycling (BEC) model, we resolve the nitrogen cycle focusing on the two Oxygen Minimum Zones (OMZs) of the Eastern Pacific. These OMZs are nitrogen loss hotspots, with roughly 80% of the water column nitrogen loss estimated to occur in these zones (DeVries et al., 2012; Hattori, 1983). We plan to investigate the effects of (sub)mesoscale and interannual variability on the nitrogen loss processes and the denitrification to anammox ratio. Additionally, we will study the dynamics of nitrous oxide (N₂O), a potent greenhouse gas, which is produced under suboxic conditions by incomplete denitrification or as a byproduct of nitrification (Babbin et al., 2015). This work will contribute to a better understanding of the processes occurring within OMZs – regions that are likely to expand under climate change (Busecke et al., 2022).



Map of the ROMS-BEC model domain with a snapshot of the modelled water-column nitrogen loss in color. The telescopic model grid is depicted by every 20th grid point. 46

Eco-corona formation on plastics: Adsorption of dissolved organic matter to pristine and photochemically weathered polymers.

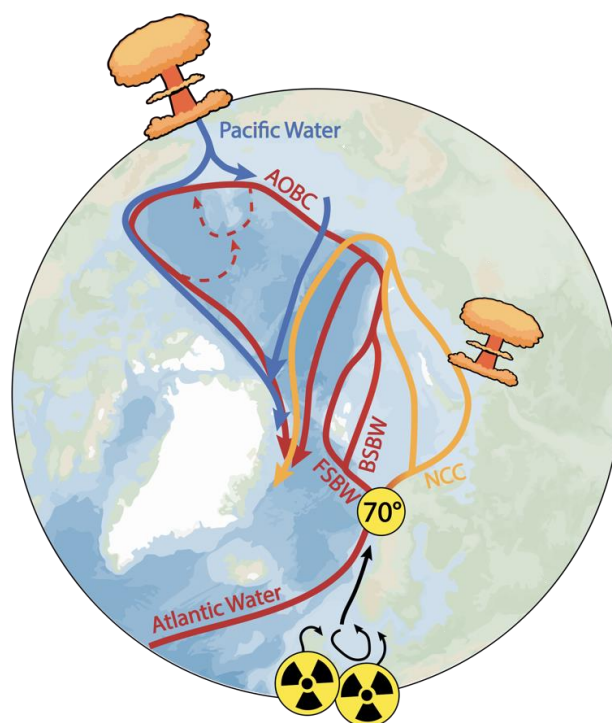
Particulate plastic fate in freshwater systems is dependent on particle size, morphology, and physicochemical surface properties (e.g., charge, surface roughness, polarity). Photochemical weathering and eco-corona formation due to dissolved organic matter (DOM) adsorption are two important environmental aging processes that can impact the physicochemical properties of plastics and may influence their fate and transport. Using more realistically aged plastics for laboratory experimental systems is important, but the impact(s) of photochemical weathering and DOM adsorption on the physicochemical properties of plastic is often not fully characterized. This work provides a systematic analysis of the adsorption of environmentally relevant DOMs to the surfaces of the most environmentally prevalent polymers in both pristine and photochemically weathered forms. The DOM adsorption was assessed by quartz crystal microbalance with dissipation measurements, which showed a lower DOM adsorption and hydration on photochemically weathered polymers compared to pristine ones. While initially different polymers had distinct physicochemical surface properties, upon aging (photochemical weathering and DOM adsorption) they became more similar in terms of surface properties. Photochemical weathering induced a decrease in polymer thickness, increase in surface roughness and polarity. Adsorption of DOM introduced more similar wettability characteristics. Collectively, this study provides evidence that aging processes reduce the heterogeneity of plastic surface characteristics of plastic particles and helps to develop more realistic aged reference materials for fate, transport and ecotoxicity studies of plastics in aqueous environments.



Adsorption of DOM on pristine (dark blue) and photochemically weathered (clear blue) polymer, measured by QCM-D.

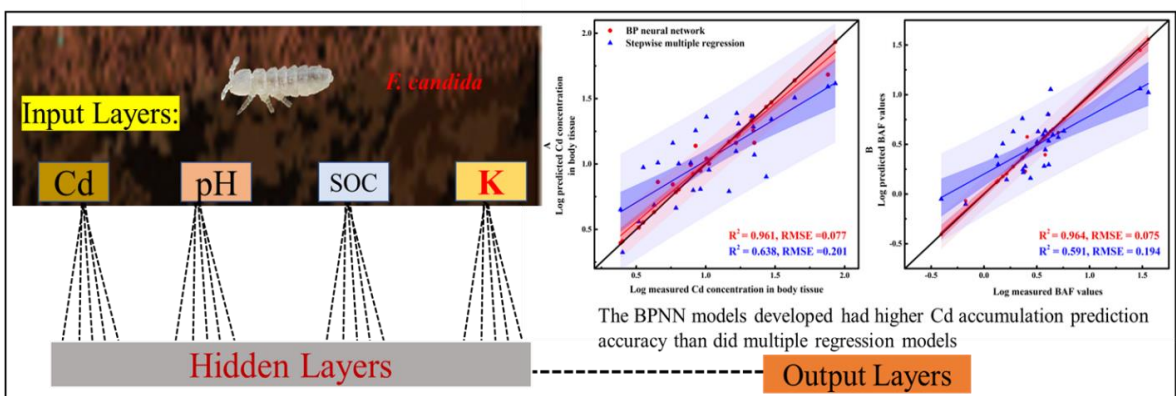
A new compilation of Anthropogenic Radionuclides and Transit Time Distributions in the Canada Basin.

Anthropogenic radionuclides iodine-129 and uranium-236 released from Nuclear Reprocessing Plants in Europe label Atlantic Water (AW) entering the Arctic Ocean and trace its pathways across the region to the Canada Basin. The time-dependent releases of both nuclides to the marine environment allow estimates of transport times and degree of mixing using the transit time distribution (TTD). Here we present the first high-resolution study of the tracer labelled AW in the Canada Basin. Results show that tracer ages at the surface yield an estimated age range of 25 - 35 years, although with significant dilution, and are supported by TTD mode ages spanning from 15 to 32 years for the core of the AW layer. We find that within the AW, input concentrations of the tracers are conserved along the flow path, with minimal dilution, indicating a dominantly advective and stable flow, although there is lateral mixing within the AW layer itself. We also observe that there is significant spatial variation in the distribution of ages across the basin from North to South, which indicates two pathways of Atlantic waters into the Canada Basin: one going across the Chukchi Plateau and the other one around it.



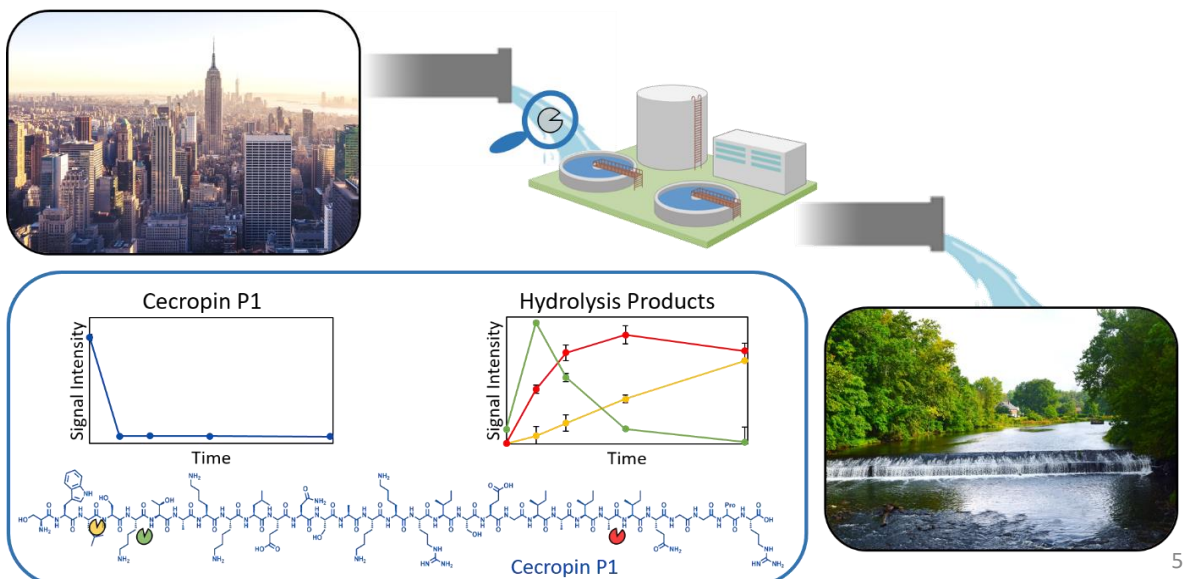
Predictions of Cadmium toxicity and accumulation to soil collembolan by BPNN models.

Accurate prediction of cadmium (Cd) toxicity and accumulation is important in the maintenance of soil ecological health. However, most studies are based on multiple linear regression models and conducted on newly Cd-spiked soils, and the results cannot be compared with naturally Cd-contaminated soils. Here, a standard single-species toxicity test was conducted using the standard collembolan *Folsomia candida* on 28 naturally Cd-contaminated soils from across China and the back-propagation neural network (BPNN) model was used to predict Cd toxicity to and accumulation in the collembolan. The performance of the BPNN model was significantly higher than that of multiple linear regression. Soil potassium was also a major factor affecting soil collembolan Cd accumulation as well as soil total Cd content and pH in naturally contaminated soils, and when the total Cd concentration was $< 3 \text{ mg kg}^{-1}$, soil pH was the major factor restricting collembolan survival rather soil Cd concentration. This study provides direct evidence of the necessity of studies on nutrient elements in metal accumulation by soil animals and the developed BPNN model may be used as a new and rapid tool for the prediction and practical monitoring of Cd ecotoxicity in naturally contaminated soils.



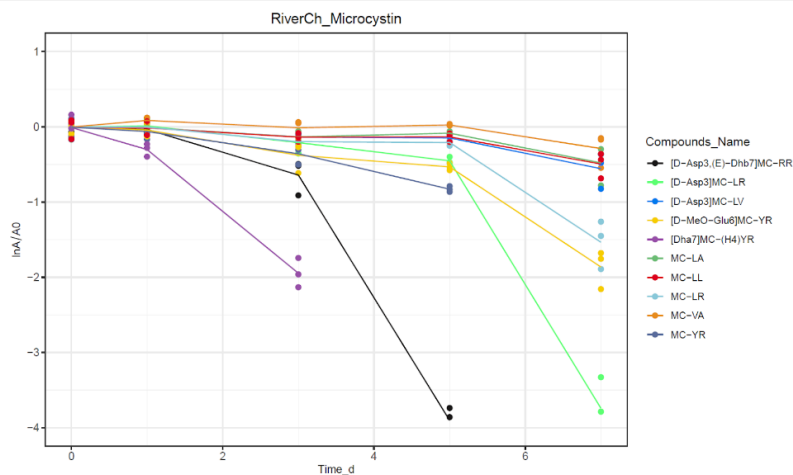
Biotransformation of Antimicrobial Peptides by Wastewater Peptidases.

After administration, considerable amounts of active antibiotics are excreted and enter wastewater streams. Conventional wastewater treatment plants (WWTPs) are incapable of removing all antibiotics during the treatment process, resulting in the release of active antibiotics into natural environments. In wastewater and natural environments, the presence of antibiotics might contribute to the emergence and spread of antibiotic resistances, which poses a threat to human health. Antimicrobial peptides (AMPs) constitute a class of promising antibiotics - including several compounds that showed a slower resistance evolution in bacterial strains compared to small-molecule antibiotics. However, little is known about the fate of AMPs in wastewater and about the activity and specificity of peptidases in wastewater. Therefore, we investigated the capacity of wastewater peptidases to hydrolyze AMPs. First, we quantified extracellular peptidase activities throughout the treatment process at four full-scale WWTPs. Then, we incubated a set of ten AMPs with wastewater extracts showing highest peptidases activity. Using liquid chromatography coupled to high-resolution mass spectrometry (HPLC-HRMS), we found that the selected AMPs show large variations in their susceptibility to hydrolysis by wastewater peptidases. For rapidly hydrolyzed AMPs, we identified transformation products of single peptide bond hydrolysis events and found a remarkable conservation of peptidase specificity across the tested WWTPs.



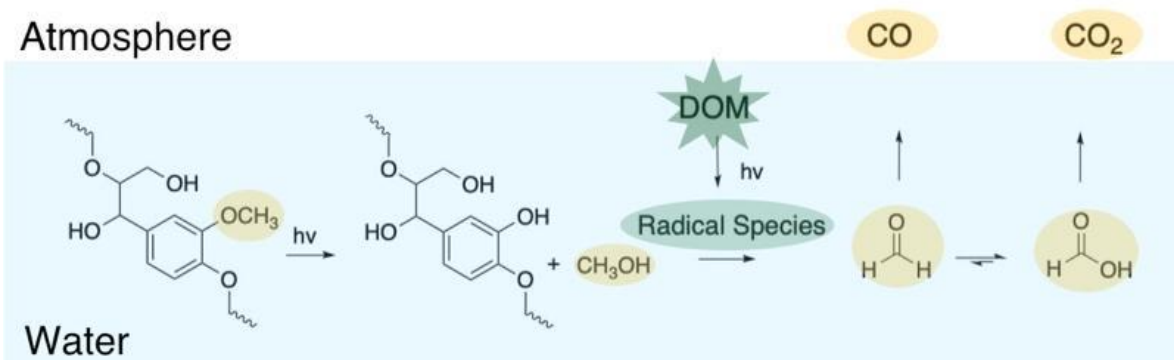
Seasonal patterns of cyanobacterial metabolites and their biotransformation in surface waters.

Cyanobacteria harmful algal blooms (CyanoHABs) are increasing globally in frequency, magnitude and duration, and posing threats to aquatic ecosystems and human health especially by the release of toxic metabolites. Adverse effects are amplified during the decay phase of bloom events when lysed cells release intracellular metabolites. Thus, knowing the lifetime of released toxins in surface waters is of great significance. In my study, we determined long-term toxins and metabolites profiles in Lake Greifensee over 4 years. We then explored the biotransformation of a wide range of secondary metabolites including the classes of anabaenopeptins, cyanopeptolins, microcystins and cyclamides produced by bloom forming cyanobacteria. Surface waters and suspensions of biofilms grown in-situ were used in mesocosm incubation setups to evaluate biotransformation potential of extracted metabolites. Liquid chromatography coupled by high-resolution tandem mass spectrometry was applied to identify metabolites and determine concentration changes over time. Transformation in raw surface waters was hardly detectable ($t_{1/2} > 50$ d) for most metabolites. In suspensions with enhanced in-situ biomass, the metabolites proved to be prone to biotransformation. We observed metabolite class- and compound-specific kinetics. We explored site-specific effects towards structure-reactivity dependencies to generalize which metabolites are more labile or persistent. With that, we aim to evaluate the overall role of biotransformation processes on the fate of cyanobacterial metabolites in surface waters.



The Photochemical Role of DOM On The Cycling Of Carbon To The Atmosphere.

The photochemical transformation of naturally occurring organic molecules in the aquatic environment is an essential component of element cycling processes and important in ecosystem function. Photochemistry is not only involved in the buildup of organic molecules through photosynthesis in these systems, but also in their degradation. For example, the degradation of dissolved organic matter (DOM) via photoirradiation can lead to an increase in biologically labile DOM (lower molecular weight components) which can provide bacteria with essential nutrients, but additionally leads to the steady state concentration of LMWC's in the environment. Our previous project determined that the irradiation of plant matter such as lignin could lead to the production of methanol and CO. Which meant that the LMWC's produced from DOM irradiation could also undergo photochemical oxidation to CO and maybe CO₂. This led us to investigate how this could occur in a natural environment, using DOM and its photoproducts as the reactants with our C1 compounds such as methanol, formaldehyde, and formic acid. We investigate their photochemical transformation using ¹³C labeled C1 compounds and irradiate them in the presence of DOM, following also the production of atmospherically relevant gases such as CO and CO₂. We do this by using ¹³C sensitive techniques; NMR, CRDS and GC-IRMS, which allows for us to follow their unique reactivity independent of convoluted number of species already produced by DOM.



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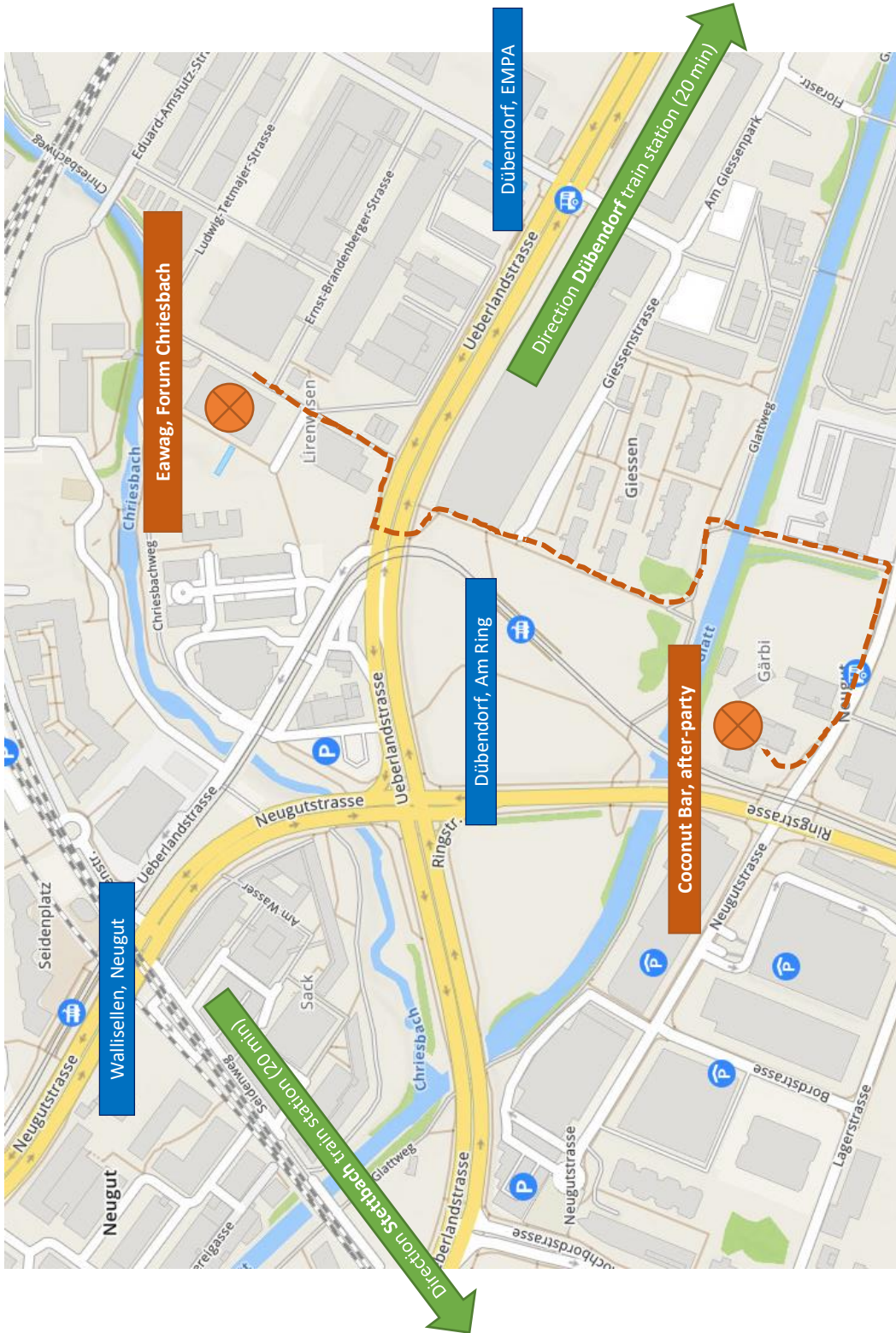
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Maps to access Eawag and main rooms of the congress



The after-party takes place at the Coconut bar,
Neugutstrasse 66, 8600 Dübendorf,
10 minutes walk from Eawag

**Thanks for attending the
congress!**

