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PROGRAM

Abstracts

Session 1 - The microscopic engines of the oceans: role and strategies of marine microbes in a changing world

Session host: A. Elisa Hernández-Magaña (1), Belén Franco-Cisterna (1), Bianca Biedrawa (2) and Michael Lintner (2)

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When you think about an engine, you probably visualize a big machine or some powerful device. Marine microorganisms are not precisely big, but they are powerful: they drive important mechanisms at global scales. Their role in the general circulation of elements on the Earth and in other life processes makes microorganisms key components in maintaining this planet working as well as the global ocean. In marine ecosystems, microorganisms play fundamental roles in all kinds of environments, including extreme habitats, where they have fascinating adaptation strategies. Even more, microorganisms are crucial for the development of our modern society. The knowledge about microbial diversity, physiology, and ecology has prompted great progress in medicine, industry, and research.

Despite the importance of microbes, only a small percentage of microbial diversity is known, revealing a vast world of metabolisms, genes, interactions and more to be discovered. Thus, their study turns crucial in the context of climate change, which can lead to more extreme habitats and, consequently, to have an impact on microbial communities.

Expanding our knowledge about marine microorganisms and understanding how the interactions between microbes, other organisms and the environment drive the diversity patterns and marine functioning in the present and in possible future scenarios are the aims of this session. As well as, opening the dialogue and discussion about the current research on the role of these organisms, and how they can help us to predict the ocean responses towards projected climate change or, even, to find solutions to environmental problems caused by human activities.

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OP1-S1 Influence of upwelling intensity on environmental variables and phytoplankton community composition in the Peruvian upwelling system during austral summer 2018-2019

The Peruvian coast is characterized by upwelling of cold and nutrient-rich subsurface waters caused by persistent equatorward winds that drive offshore Ekman transport. The supply of nutrients to the euphotic zone subsequently drives enhanced phytoplankton growth supporting highly productive ecosystem. Regional differences in wind intensity produce a variable environment on various spatial and temporal scales that affect the biomass and composition of the phytoplankton community. Here we combine Ekman transport, in-situ oceanographic measurements and pigment analysis to (i) characterize the upwelling intensity in six cross-shore transects sampled along the Peruvian coast during summer 2018-2019, (ii) to relate the chlorophyll a (chl-a; used as a proxy for biomass) to the upwelling history in each transect and

(iii) explain the patterns of phytoplankton composition. Signatures of freshly upwelled waters, including lower temperatures and elevated nutrient concentrations were detected close to the shore in transects with high Ekman transport recorded during the cruise. In contrast, transects with low Ekman values were characterized by the presence of stratified and oxygen-rich waters. Tracking back the upwelling history a week before the cruise took place, we show that high biomass has accumulated along transects with high Ekman transport supported by the nutrient input in surface waters. This was more pronounced along transects where upwelling relaxation followed, and favoured the retention of phytoplankton. Chl-a remained restricted to ~25 km from the coast in transects with low upwelling intensity. A clear succession in phytoplankton composition was observed, with diatoms being abundant in freshly upwelled waters, while a shift to a more mixed, dinoflagellate-dominated community was seen in more mature waters. The coastal region in the most southern part was an exception, and although high upwelling was recorded before and during the cruise, a dinoflagellate bloom was observed, where the mixotroph *Akashiwo sanguinea* was >90% of the phytoplankton community.

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OP2-S1 Extreme weather events: How does increasing riverine discharge affect phytoplankton community composition and elemental stoichiometry?

Marine organisms do not only have to face increasing CO_2 levels and temperatures due to global change, but also an increasing frequency and intensity of extreme weather events. Higher amounts of precipitation lead to greater riverine inputs, which increase nutrient concentrations and decrease salinity in coastal waters, such as the North Sea. Phytoplankton are directly affected by environmental conditions, and pulses of nutrient-rich freshwater are likely to alter the biomass, species composition, and cellular elemental composition of coastal marine phytoplankton. To address this issue, we conducted an experiment during a cruise in the North Sea. We tested the impact of an abrupt increase in nutrient concentrations and decrease in salinity on natural phytoplankton communities sampled at three stations from the Dutch coast to the open sea. We incubated the phytoplankton communities with 10, 20, and 30 % of nutrient-enriched freshwater for 72 h. Overall, we observed an increase in biomass with higher nutrients and freshwater loads, and an analysis of the bulk C, N, and P cellular content revealed a decrease in C:N:P ratios. Further analysis of the phytoplankton community will provide more information on shifts in species composition. These results could have important consequences for higher trophic levels since rapid increases in phytoplankton biomass and decreases in C:N:P ratios may have a local positive effect on planktonic primary consumers.

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OP8-S1 Nitrogen fixation in the Baltic Sea

The Baltic Sea is characterised as a semi-enclosed brackish Seta which over the last ~100 years experienced eutrophication, increased hypoxia area and increased temperature by 0.6° C decade^{-1} making Baltic Sea one of the area's most severely impacted by climate change. Biological fixation of dinitrogen gas (N_2) is an essential process in order to make atmospheric N_2 available for marine life. This process is processes by specialised organism called diazotrophs and is catalysed by the energetic-

consuming enzyme nitrogenase. Nitrogenases exists in three subtypes depending on their metal cofactors, (1) the most common molybdenum-dependent (Nif), (2) the vanadium-dependent (Vnf) and (3) the Iron-Iron-dependent nitrogenase (Anf). To date, the differential effect of climate change on those three enzyme subtypes has not been explored. However, especially the predicted ongoing oxygen loss in the ocean may limit the availability of Mo. Consequently, it may trigger a shift from the abundant Nif-type nitrogenase to Vnf or Anf and therefore a potential shift in the diazotrophic community. In this study we explored the climate change-related pressures on N_2 fixation and the diazotrophic community based on both *nifH* and *vnf/anfD* amplicons. We found at the time of sampling a post-bloom high-nutrient low-chlorophyll situation wherein the major part of the diazotrophic community consisted of the cyanobacterial groups, *Nodularia* and UCYN-A. We observed a horizontal change in the cyanobacterial group where UCYN-A were the dominant fixers at 20 m. The alternative nitrogenases *vnf/anfD* were mostly associated with *Rhodopseudomonas* and based on qPCR is expressed in the surface water from 5 to 20 m. This paper presents the first hint of active nitrogenases in surface water and further establish UCYN-A as a significant player in Baltic Sea primary production.

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OP3-S1 Microbial nitrogen cycling associated with sinking krill carcasses

Krill are an important vector for nitrogen cycling in the oceans. Living organisms release significant amounts of ammonia through sloppy feeding, excretion, and egestion but carcasses contribution is barely known; despite other zooplankton carcasses, like copepods, are a hotspot for the anaerobic N-cycling and microbial production in the otherwise oxic environment. Here, through oxic incubations with ^{15}N-stable-isotope-enrichment, we investigated the microbial N-cycling in carcasses of the subarctic krill *Meganictyphanes norvergica* (predator) and *Thysanoessa raschii* (herbivore) from Godthåbsfjord, Greenland. Dissolved inorganic nitrogen and bacterial abundance in the surrounding seawater were also measured.

Sinking krill carcasses released 8.1 ± 9.9 and 2.0 ± 2.3 µmol N ind^{-1} d^{-1} of ammonium for predators and herbivores, respectively. Anaerobic N-cycling via denitrification was exhibited at 18.7 ± 37.1 and 16.8 ± 43.9 nmol N ind-1 d^{-1}, and dissimilatory nitrate reduction to ammonium (DNRA) at 30.1± 77.2 and 13.8 ± 17.0 nmol N ind-1 d^{-1} for predators and herbivores, respectively. Predators showed the highest rates per individual due to differences of >1.6-fold in length and carbon/nitrogen content respecting herbivores. However, given the carcasses abundance, the ammonium release via degradation and DNRA, and the N2 production via denitrification by herbivores were ~2- and ~7-fold higher than by predators, respectively. Denitrification in krill carcasses was >8-fold higher than in copepod carcasses, but 3-4 orders of magnitude lower than in sediments in the fjord. Carcass degradation promoted the growth of free-living bacteria, reaching peak abundances that were ca. 100 times higher than in control incubations without carcasses.

Our results suggest that sinking krill carcasses have a low contribution to the nitrogen loss in the pelagic environment. Instead, provided a measured sinking rate of >1500 m d^{-1}, krill carcasses can be an important source of labile compounds for the benthic food webs in the Arctic ocean.

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OP4-S1 Organic mater transport by cyclonic eddies formed in EBUS supports heterotrophy in the open oligotrophic ocean

Mesoscale eddies formed in Eastern boundary upwelling systems are elementary components of ocean circulation and play important roles in the offshore transport of organic carbon and nutrients. Yet, most of our knowledge about this lateral transport and its influence on biogeochemical cycles relies on modelling studies and satellite observations, while in situ measurements of biogeochemical parameters are scarce. For example, little is known about the effects of mesoscale eddies on organic carbon distribution, microbial activity, and organic matter (OM) turnover in the open oligotrophic ocean. To address this gap, we investigated the horizontal and vertical variability of phytoplankton and bacterial activity as well as dissolved organic carbon along a zonal corridor of the westward propagation of eddies between the Cape Verde Islands and Mauretania in the Eastern Tropical North Atlantic (ETNA). We additionally collected samples from a cyclonic eddy along this transect at high spatial resolution. Our results indicate a strong impact of cyclonic eddies on both microbial abundance and metabolic activity in the epipelagic layer (0–200 m). Generally, all determined parameters (bacterial abundance, heterotrophic respiration rates, bacterial biomass production, bacterial growth efficiency, bacterial carbon demand and net primary production) were higher in the eddy than in the stations along the meridional transect. Along the transect, microbial biomass and activity rates were gradually decreasing from the coast to the open ocean. We further observed high variability of biogeochemical parameters within the eddy with elevates microbial abundances as well as process rates in the south-western periphery. This can be explained by the rotational flow of the cyclonic eddy, which perturbs local OM and nutrient distribution via azimuthal advection. The local positive anomaly of microbial activity in the cyclonic eddy compared to all other stations including the near coast ones results from eddy pumping of nutrient into the epipelagic layer that promotes growth of phytoplankton. Overall, our study supports that cyclonic eddies are important vehicles for the transport of fresh OM that fuel heterotrophic activity the open ocean, highlighting the coupling between productive EBUS and the adjacent oligotrophic ETNA.

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OP5-S1 Influence of multiple global change scenarios on carbon fluxes and antioxidant response in the diatom *Phaedactylum tricornutum*

Diatoms are major contributors to the carbon cycle in aquatic system and their physiological performance is highly affected by environmental change. Ocean acidification and rising water temperature are among the global change processes expected to have the most intense effect on phytoplankton metabolism. Additionally, changes in nutrient inputs into coastal waters are shifting the nitrogen:phosphorus ratio towards P-limitation. Here, we manipulated temperature (18 vs. 21°C), pCO2 (400 vs. 1000 μatm), and dissolved N:P ratios (16 vs. 25), using a full factorial design, to study the impact of different global change scenarios on the coastal model diatom *Phaeodactylum tricornutum*. We particularly focused on the cellular fluxes of carbon and the effect of harmful byproducts associated to the carbon metabolism, such as reactive oxygen species (ROS). Our results show that, when combined, higher temperature, pCO2, and

N:P affect cellular physiology the most, specifically by increasing photosynthetic rates and DOC exudation, and by decreasing respiration as well as cellular carbon content. Moreover, cells grown in 21°C showed higher Alternative oxidase contribution to the total respiration, a pathway often activated in phytoplankton to avoid formation of ROS in the mitochondrial electron transport system. As higher temperature reduced the activity of enzymes involved in the cellular antioxidant response, such as Glutathione S-transferase, Glutathione peroxidase and Manganese superoxide dismutase, lipid peroxidation increased, a marker of oxidative damage. Overall, our work demonstrate that predicted global change scenarios (higher temperature and pCO2 as well as lower P availability) can negatively affect the metabolic performance of phytoplankton in coastal waters by lowering cellular C content and by increasing oxidative stress.

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OP6-S1 Impact of algal food quality succession on grazing by microzooplankters at Helgoland Roads during the 2020 spring bloom

Phytoplankton form the basis of the marine food web and play key roles in biogeochemical cycles, producing oxygen and transferring energy and nutrients to higher trophic levels. As temperature and light availability increase, dense algal blooms occur during spring in temperate systems. These so-called spring blooms can be controlled by zooplankton grazing. Microzooplankton (20-200 μm) in particular can consume up to 80% of the daily primary production. However, the factors driving the grazing of microzooplankton are still poorly understood, especially in nature. Here, we conducted a series of experiments to study grazing and selective feeding during a spring bloom event. We aimed to unravel how the specific succession in food quality, i.e. the particulate carbon : nitrogen : phosphorus (C:N:P) ratio and total lipid content, is impacting microzooplankton grazing during the 2020 spring bloom. We expect to find a decline in algal food quality over the duration of the bloom resulting in a decrease in grazer biodiversity and a decrease in grazing pressure. During different phases of the bloom, we determined sestonic C:N:P ratios and lipid content, and we performed 24 h grazing dilution experiments. This study will ultimately yield new insights in the factors that drive the top-down control by microzooplankters on phytoplankton blooms.

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OP8-S1 Identification of the siderophore biosynthesis pathway in an epibiont of the cyanobacteria *Trichodesium sp.*

Siderophores are high affinity iron (Fe) binding ligands that play an important role in increasing Fe-availability to marine microorganisms by dissolving Fe-colloids and particles. Colonies of the ecologically important cyanobacteria *Trichodesmium* sp. can supply both carbon and fixed nitrogen to their associated bacteria and form hotspots for siderophore-promoted Fe-dissolution. To explore these mutualistic interactions, we isolated and sequenced the bacterium *Psychrobacter pacificensis* Eilatius from natural *Trichodesmium* sp. colonies from the Gulf of Aqaba in the Red Sea. When grown under Fe-limitation, *P. pacificensis* Eilatius synthesizes and releases the siderophore ferrioxamine E with traces of ferrioxamine G. Its genome contains a single siderophore biosynthetic gene cluster (BCG) that comprises of 11 genes, including 3 non-ribosomal peptide synthetase independent siderophore (NIS) synthetases. While the arrangement of these genes highlights the ability for *P. pacificensis* Eilatius to synthesize NIS- type siderophores, the BGC does not match to any known ferrioxamine synthesis pathways. Instead, it resembles the synthesis pathway of baumannoferrin, a siderohore notably produced in *Acinetobacter* strains. We hereby speculate that this particular BGC, which is conserved within several members of the Moraxellaceae family, is involved in the synthesis of more than one siderophore. While biochemical characterization of this BGC in relation to desferrioxamine production is needed to delineate its exact biosynthetic mechanism, our findings highlights the potential for a siderophore BGC to be more versatile in their ability to produce siderophores than what can be predicted from in silico analysis alone. The co-occurrence of *Psychrobacter* species with *Trichodesmium* sp. colonies isolated from this region appears to be relatively consistent and further suggests that *P. pacificensis* Eilatius can form an important association with *Trichodesmium* sp. colonies with regards to siderophore production in the Gulf of Aqaba. Finally, the BGC reported in this study will help in the development of molecular probes to further explore the role of bacteria in Fe-dissolution by *Trichodesmium* sp. colonies.

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FP2-S1 The planktonic microbiome of the Atacama trench

Hadal trenches are one of the deepest regions of the ocean exceeding 6000 m below the surface where there is no trace of sunlight, temperature is low (1.0 - 2.5°C) and hydrostatic pressure is the highest (> 600 standard atmosphere). In these environments macroscopic organisms are scarce due to the extreme conditions, yet they are rife with microbial life. There are 33 trenches, but we only have knowledge of the planktonic microbial community composition of the Puerto Rico trench in the Western North Atlantic Ocean and more exhaustively the Mariana, Kermadec and Japan trenches in the Western North Pacific Ocean. The Atacama trench is the only one in the Eastern South Pacific, specifically off the coast of Peru-Chile. In order to characterize its planktonic microbial community, water samples were collected from the surface to just over the sea bottom to analyze the V4-V5 16S rRNA gene sequences from the free-living (0.2 - 3 µm) and particle-associated (3 - 20 µm) size fractions. The Atacama trench held a significantly distinct microbial community from other trenches. Pelagic zone and size fraction were also important drivers of community structure. 8.5% of the operational taxonomic units (OTUs) obtained from the Atacama trench and overlaying waters were exclusively hadal. The most abundant taxa were Thaumarchaeota (domain Archaea) and Bacteroidetes, Marinimicrobia, Planctomycetes, Gammaproteobacteria, Pelagibacterales and other Alphaproteobacteria (domain Bacteria). Pelagibacterales were remarkably more abundant in the Atacama trench than in other trenches in the free-living (10 - 20%) and particle-associated fraction (3 - 12%). This study indicate that the distinct microbial community of the Atacama trench is composed of

both, allochthonous and endemic microbes and reaffirm the idea that every trench has its own unique hadal biosphere.

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OP9-S1 Decomposition of marine copepod carcasses: Effects on bacterial community and its importance for N cycling in oxygen depleted waters

Copepods are the most abundant mesozooplankton in the ocean and their carcasses are subject to decomposition by bacteria. We investigated bacterial decomposition of the carcasses of the copepod Acartia tonsa under contrasting oxygen conditions. In oxic condition, signs of decomposition were visible after 12 h; by 36 h only the carapace with a trace amount of internal tissues remained. The decomposition process was initially delayed in the anoxic condition, but it then accelerated after 18 h, with only carapace remaining at the end of the experiment. Illumina sequencing of the 16S rRNA gene revealed the dominance of Verrucomicrobiaceae and Rhodobacteraceae associated with the carcasses in oxic condition, and mainly Vibrionaceae and Rhodobacteraceae in anoxic conditions. *nir*K and *nos*Z genes were undetectable in the oxic treatment, but increased significantly through time under anoxic condition, suggesting that copepod carcasses could be microbial hotspots for denitrification in oxygen-limited water.

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OP10-S1 Predating the Suez Canal: Documentation of the native benthic foraminiferal assemblage of the Levantine Sea

The opening of the Suez Canal in 1869 enabled species from the Red Sea (Lessepsian invaders) to migrate into the Mediterranean Sea and thus overcoming a long-standing biogeographical barrier between these two seas. There has been an increasing number of publications that reported the presence of invasive and non-native species in the Mediterrean Sea, among which foraminifera can be found. The focus of these studies lies on the most recent part of the migration process, however, we know little about the time between first appearance and successful population establishments of non-native foraminifera in the Eastern Mediterranean Sea.

This lack of information about the untouched native communities of benthic foraminifera and their change under the pressure of the Lessepsian invasion hinders us to fully understand the invasion process and our analyses of the impact it had on the non-native foraminifera communities.

To fill this gap in information, we analysed a sediment core collected off Atlit (Northern Israel) at a water depth of 40 meters. The sediment composition of the core was characterized by a distinct greater proportion of coarser sediments in the top 10 cm. The total assemblage of foraminifera (>63 μm) was determined every 5 cm.

Our results show the assemblage of benthic foraminifera before the opening of the Suez Canal. The older part of the core shows a high diversity of porcellaneous and calcareous species, among which *Asterigerinata mamilla*, *Elphidium crispum* and *Planorbulina mediterranensis* dominate. The top 10 cm of the core show an altered community structure, higher total abundances and the presence of non-native species. Correlating the grain sizes with the number of species and number of individuals shows a positive and significant relation between grain sizes and foraminifera in this region. The top 10 cm was also the frame in which most non-native species were present (7 in total).

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OP11-S1 Tracking microbial signatures associated with the anaerobic oxidation of methane in the deep biosphere off Argentina

Methane is an important greenhouse gas, with a higher warming effect than carbon dioxide. Marine anoxic sediments are one of the largest sources of methane, together with anthropogenic sources. However, methane emission to the Ocean and above is limited by the anaerobic oxidation of methane (AOM), a microbial-driven process, which acts as a sink for methane produced in the deep anoxic sediments. AOM was first shown to be performed by a consortium of methanotrophic archaea and sulfate reducing bacteria. Recently, a new process of AOM was discovered involving methanotrophs and iron reducers, but with no pure culture of these organisms available yet, microbial interactions are only partly understood. Considering the prime importance of methane in the global carbon cycle and its impact on climate change, a better understanding of these processes become increasingly important.

In this study, lipid biomarker analysis and isotope biogeochemistry were combined to investigate AOM processes at the Argentine continental margin. Additionally, a new approach of mass spectrometry imaging was used to map lipid biomarkers and elemental distributions on a microscale.

Changes in the isotopic composition of methane and dissolved inorganic carbon show that the deep biosphere off Argentina, hosts a microbial community, actively oxidizing methane. The analyzed lipid biomarkers show indication for AOM-associated biomass, but with a strong diluting imprint of water column-derived material. This diluting signal influences the carbon isotopic signature of the investigated biomarkers. On the contrary to the homogenous down core signal from conventional biomarker analysis, the microscale mapping shows a spatial heterogeneity in biomarker and elemental distribution, interpreted as potential hotspots of microbial activity.

This study highlights that the new approach of investigating microbial communities by microscale mapping of biomarkers is a powerful tool towards tracking microbial processes in sediments, uniquely revealing linkages between organic and inorganic constituents.

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OP12-S1 Benthic foraminifera track the environmental History of the south-eastern North Sea during the Early Modern Period

Particular heavy metals e.g. zinc serve as micronutrients for eukaryotic life and play an important role for cellular metabolism, growth of organisms, reproduction and enzymatic activity. They occur naturally in the environment as trace ingredient in soils, water, rocks, plants and animals. However, in higher concentrations, most heavy metals become toxic and have serious hazard effects on marine biota. Furthermore, they are highly persistent in the marine environment and can be hardly degraded by organisms. Especially coastal environments act as natural catchment basins for anthropogenic pollutants because these areas are highly affected by industry, agriculture and urban runoff. Therefore, it is vitally important to assess past spatial and temporal distribution patterns and to compare those with recent pollution in order to evaluate contemporary emission reduction measures. An emerging paleo-tool is the heavy metal incorporation into foraminiferal shells calcite, which offers monitoring of anthropogenic footprints on the environmental system. Heavy metal records in foraminiferal tests along a sediment core from the North Sea track pollution events of local (e.g. shipyard, ironworks and metallurgy) and global (e.g. market cycles) origin. We analysed the heavy metal concentrations in tests of *Ammonia batava* (Mn, Zn, Cd Cu etc.) by laser ablation ICP – MS measurements. These metals reveal the pollution history of the North Sea during the last 500 years with focus on the Early Modern Period.

Session 2 - Assessing the real concentrations of microplastic and their actual effects on marine biota

Session host: Lukas Novaes Tump (1) and Mel Constant (2,3)

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Microplastics were discovered almost everywhere we searched for them, including groundwater, deep sea, atmospheric fallout and even pristine places far from human activities. Possible threats for marine life include physical injury though ingestion or toxicological effect of additives and adsorbed pollutants. But as a well-established framework for this rather new field of research is still missing, many questions are yet to be answered. While the amount of microplastic is predicted to double by 2030 in some parts of the ocean, guidelines and profound methodologies are urgently needed.

In this session we want to address two major difficulties in microplastic research:

1. The methodology to assess microplastic in the environment as well as their concentrations differ significantly between studies. In this session we want to discuss how to measure the pollution in the environment from source to sink.

2. Similarly, the assessment of microplastic effects encounter methodological issues. Effects caused by the high particle loads used in microplastic research have probably been misinterpreted as plastic effects, due to a misappropriate or inadequate comparison. Indeed, The majority of studies compare the performance of organisms exposed to microplastic to organisms that were not exposed to any kind of particle. However, negative effects caused by high natural particle concentrations have been proven manifold. To avoid this problem a new experimental approach was designed, where microplastics were compared to a fitting natural particle of the same size and concentration, instead of a particle less reference group.

We also propose to open the discussion on possible solutions for the plastic problem: *Are there ways to remove the pollution?*

To conclude, we would like to host a session to discuss the methods and outcomes of our studies with experts and young researchers interested in the field of microplastic. We intend to create room for an open dialogue and constructive critique to pave the way for the future generation of microplastic researchers.

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OP1-S2 Understanding Micro(Nano)plastic as a Global Pandemic

Fragmented or otherwise miniaturized plastic materials in the form of micro- or nanoplastics have been of nagging environmental concern. However, in the past few years, scientists have started using the term nanoplastic for particles smaller than a few micrometres. The differentiation is useful because such small particles are very difficult to isolate from their environment with simple methods, such as filtration, that can be used for microplastic. Furthermore, at so small a size, there is a potential risk that instead of being simply stuck in the guts of living organisms, nanoplastic can penetrate tissues much more easily than larger specimens. This review summarizes the results of cutting-edge research about the interactions between a range of aquatic species and microplastics, including effects on biota physiology and secondary ingestion. Uptake pathways via digestive or ventilatory systems are discussed, including the physical penetration of microplastic particles into cellular structures, leaching of chemical additives or adsorbed persistent organic pollutants (POPs), and consequences of bacterial or viral microbiota contamination associated with microplastic ingestion. Following uptake, a number of individual-level effects have been observed, including reduction of feeding activities, reduced growth and reproduction through cellular modifications, and oxidative stress. Microplastic associated effects on marine biota have become increasingly investigated with growing concerns regarding human health through trophic transfer. Most studies have been conducted on fish; knowledge is needed about the effects of microplastic on other groups of organisms, especially invertebrates. Furthermore, there are significant mismatches between the types of microplastic most commonly found in the environment or reported in field studies and those used in laboratory experiments. Finally, there is an overarching need to understand the mechanism of action and eco-toxicological effects of environmentally relevant concentrations of microplastic on aquatic organism health.

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OP2-S2 Micrplastic accumulation in different depositional environment of Kepulauan Seribu complex, Indonesia

Presently the most abundant marine litter is plastic. Marine litter is accumulating at the beach, floating on the oceans, and finally accumulating on the seafloor. Microplastic accumulates in benthic sediments and shorelines with harmful effects to the environment due to its small size. Ingestion of microplastic by reef corals with potentially detrimental effects on coral growth was observed in laboratory experiments. Microplastic is reported to have the ability to adsorb toxic chemicals from surrounding sea water, which can be pathologic if consumed by marine animal. Plastic waste also carries pathogens that are held

responsible for the outbreaks of disease on coral reefs. Microplastic therefore poses a threat to reef corals and their ability to act as framework builders in coral reef systems. Despite this, microplastic accumulation in reef systems remains largely unquantified. We aim to analyse the control of sedimentary processes on the distribution of microplastic in different carbonate environments. Microplastic in the size range from 125 µm to 1 mm is investigated in sediments from different facies zones on two islands from the Kepulauan Seribu complex, offshore Jakarta Bay. Potential sources for microplastic are mismanaged waste from densely populated islands, marine fishing, aquaculture and tourism. The result will contribute to a better understanding of the sedimentary processes that govern microplastic accumulation and distribution within different environmental and sedimentologic settings.

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FP4-S2 Microplastics in the Indian Ocean - Analyzed by Quantum cascade laser -based infrared imaging

We collected suspended particulate matter from subsurface seawater along a transect (Sonne 270 cruise) in the tropical Indian Ocean using an in-house-built fractionated filtration system (Geesthacht Inert Microplastic Fractionator, GIMPF). Samples were subjected to a microwave-assisted one-pot sample purification protocol. The validated enzymatic-oxidative protocol showed high removal rates and time-efficiency. Finally, microplastics were identified and characterized using recently introduced Laser Direct Infrared Imaging (LDIR) based on a quantum cascade laser source. This new approach bears significant advantages compared to conventional FTIR and Raman imaging approaches.

The LDIR selects a single wavelength and scans the sample slide at a very high speed (2.5 × 7.5 cm). Then, the objective is parked at a single point, while the semiconductor laser sweeps through the entire spectral range in less than one second - compared to > 30 s for focal plane array -based FTIR instruments.

Generated data on polymer types (spectral database comparison) and particle sizes (≥ 10 μm) are processed in real-time, while evaluation of FTIR data requires more post-processing-time and immense memory space.

Microplastic concentrations of 7 analyzed samples (≥ 20 μm) ranged from 10 up to 226 particles/fibers m^{-3}. The most abundant polymer clusters were acrylates/polyurethanes/varnish (39.2%) PET (26.0%), PE-Cl (7.1%), PVC (6.0%), PE (5.2%), PP (5.2%) and rubber (4.3%). 94.9% of the microplastics particles/fibers had a diameter < 100 μm.

Session 3 - Coral restoration & marine conservation

Session host: Sarah Abdelhamid (1) and Victoria Huk (1)

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The restricted range of coral reef ecosystems extends from tropical to subtropical regions. Coral reefs are one of the most precious ecosystems and an astonishing hotspot for biodiversity. Scientists estimated that almost one quarter of all discovered marine organisms found home on coralline structures. However, these beautiful ecosystems are fragile, and areas of coral are dying whilst fish stocks are under threat. Unfortunately, those stunning marine biotopes and biodiversity hotspots are highly endangered and prognosed to disappear by 2050. This would entail serious consequences for tropical marine ecosystems as well as depending human communities.

Therefore, it is absolutely necessary to allow corals a new way to grow and provide them a protected and maintained area to create new life zones. We believe that creating protected spaces and artificial reefs, which includes new coral growing through coral restoration and transplantation, may be a successful way to protect and reform coral colonies in our oceans.

Hence, this session is dedicated to marine conservation and restoration and its impact on the future health of coral reefs and other fragile ecosystems.

The aim of our session is to create an integrative and interdisciplinary surrounding as well as to bond with other scientists, enthusiastic world changers. Therefore, we invite coral researchers, artificial reef artists, marine conservationist and social scientist to share their knowledge, ideas and research on marine conservation and coral reef restoration in our session.

Steve Gerber (1)

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FP1-S3 Algal overgrowth on corals depends on colony growth form: ecological implications of contradicting findings

Benthic communities of coral reefs are under constant competition for space. Especially interactions between scleractinian corals and algae have received increasingly more attention during recent decades. As many reef systems are plagued by collapsing herbivore populations and/or eutrophication, benthic algae have started taking over, initiating so called phase shifts in which they become the dominant organisms of the reef. Such changes can have dire ecological consequences, including the loss of biodiversity and crucial ecological functions.

The competitive outcome of an interaction strongly depends on the species involved. However, previous studies have highlighted the importance of colony growth form in determining overgrowth frequency and progression. It is hypothesised that branching corals, which grow faster and have little contact with the benthos, largely aim to avoid competition. In contrast, more simple colony structures such as encrusting or massive growth forms encounter algal overgrowth much more frequently. In turn, these corals are often competitively superior and usually “win” the interaction. It has been suggested that this pattern is in accordance with the resource availability hypothesis, which describes a trade-off between avoiding competition and investing in defence mechanisms.

This study, conducted in the Red Sea (Egypt) during January and February 2020, found the opposite pattern, with branching corals being overgrown significantly more often than their encrusting or massive conspecifics. Multiple hypotheses which could potentially explain these findings are presented by the

author, including facilitated algal proliferation through reduced flow speeds and algal refuge from herbivory provided by branching structures. Although the underlying mechanisms require further investigation, important implications may be deduced for future coral conservation and restoration projects, taking coral growth forms and local current dynamics into consideration as well.

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FP2-S3 Updates on the status of *Tridacna crocea* in the Philippines with Notes on Molecular Approach Analysis

The collection sites of *Tridacna crocea* in the Philippines was listed based on the previous studies from 1986 up to the present date. Eighteen (18) studies showed the wide distribution of *T. crocea* within the country. New samples were also added to the collection by the present study from Ulugan Bay and Honda Bay in Puerto Princesa Palawan. First record of *T. crocea* in Batanes Island was also presented by this study using molecular approach identification. The amplified mitochondrial DNA cytochrome c oxidase I gene (COI) sequences of *T. crocea* and the sequences from Genbank of the *Tridacna maxima*, *Tridacna squamosa*, *Tridacna noae* and outgroup were used to construct Neighbour Joining and Maximum Likelihood tree. The information in this study contributes to the growing data on genetics of the giant clams (Cardiidae: Tridacninae). This can serve as a guide to the possible population structure

and adaptation patterns of habitat associated marine invertebrate species.

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OP1-S3 Investigating population structure of hard corals across the Chagos archipelago, Indian ocean

Coral reefs of the Chagos Archipelago, Indian Ocean, suffered severe mortality during the pan-tropical mass bleaching event in 2015 & 2016, losing approximately two-thirds of their coral populations in shallow waters (8-12m). Interestingly most coral mortality (60%) occurred after the first, and less severe, sea surface temperature (SST) anomaly in 2015, and mortality was taxon-specific affecting the competitive *Acropora* species, causing a shift in the dominant taxon from *Acropora* to *Porites*. Whether this shift in community composition becomes permanent will depend heavily on coral larvae dispersal patterns and subsequent coral recruitment to the reefs. Coral larvae dispersal patterns across the Archipelago, and the wider region, are unknown. To inform our understanding of how *Acropora* populations are connected we used a population genetic approach, assessed through sequencing of two genetic regions PaxC and Mini-collagen intron (MCOL). This knowledge helps inform how these important reefs may recover from climate change-induced SST anomalies and which 'source' reefs might be potential hotspots for priority protection. We observed a lack of genetic structure in two *Acropora* species (with some degree of isolation for *A. cytherea*), suggesting a high degree of gene flow across the atolls in the Archipelago, as a result of good larvae dispersal. This indicates the potential for recovery in coral cover given time. However, increasingly frequent and severe thermal anomalies are predicted, as a consequence of accelerating global climate change, potentially inhabiting recovery and leading to further coral loss. This study is the first step in a

project aiming to investigate fine scale population genetic patterns in the Chagos Archipelago and if the Archipelago is a possible 'stepping-stone' for coral larvae dispersal across the Indian Ocean.

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OP2-S3 The early life stages of the Mediterranean red coral (Corallium rubrum): life-history traits and skeleton formation

In the marine habitats, eco-engineering species provide a key-ecological-role in ecosystems functioning. Due to their high three-dimensional complexity, they support high biodiversity providing structure, food, and shelter for several associated organisms. Because of their carbon sequestration capacity through bio-mineralization processes, they have an important role also in the carbon cycle of the oceans. Natural and anthropogenic impacts can reduce resilience and recovery capabilities of these species. To understand the processes affecting the capability of marine species to respond to these impacts, as well as to maintain or restore their role, it is needed to implement studies on their first life-history traits. This study aimed to determine 1) some characteristics of *C. rubrum*'s life-history-traits, 2) the growth rate and 3) the skeleton ultrastructure of *C. rubrum* settlers (colonies younger than 1-year-old). To collect the planulae that later settled on suitable substrates, *C. rubrum* colonies were collected and kept in aquaria before the spawning event. The settlers were monitored for 5 months to evaluate their growth rates. Since it wasn't observed a significant growth in mean diameter during the first 5 months but a significant increase in number of polyps, this latter parameter, rather than the diameter, it's here proposed to be used as a reliable indicator of the growth in settlers. Furthermore, some of the settled individuals were sampled to observe their skeletal structure with different complementary techniques (SEM, Synchrotron tomography, LA-ICPMS). The observations of the skeletal structure have shown that the settlers don't have an axial skeleton, but a proto skeleton made up of sclerites not yet embedded in any calcitic cement. These observations emphasize the importance of these small structures which offer mechanical protection from abrasion and predation, forming a deformable, fast-growing armor to protect and accompany the fast growth of the polyps during their early stages of life.

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OP3-S3 Coral species, colony size and density drive the prevalence of *Cliona delitrix* in an artificial patch reef system

Coral reef framework is being constantly eroded by physical and biological processes. Excavating sponges are among the most important bioeroders on Caribbean reefs and are of increasing concern as reefs continue to degrade. Their population dynamics have been generally measured across sites hundreds of meters to kilometres apart and may thus be confounded by historical and environmental factors operating over the same scales. This study examined the prevalence of *Cliona delitrix* on the benthic communities of six shipwrecks less than 100 m apart in an unexposed bay in Barbados, subject to the same broad environmental conditions. These shipwrecks represent discrete patch reefs varying in age and physical, biological and small-scale anthropogenic factors. They provide an unprecedented

opportunity to identify drivers of sponge prevalence while controlling for larger scale environmental factors. We hypothesized that sponge prevalence would (1) vary among coral species, (2) increase with higher coral density, (3) increase with patch depth, (4) decrease with patch size, and (5) increase with tourist-induced nutrient inputs. The surface area, depth of penetration and host substrate of all *C. delitrix* outcrops (n=432) on all shipwrecks were measured. Any potential role of anthropogenic nutrient inputs was investigated using stable isotopes obtained from *C. delitrix* tissue. Overall, 7.6% of all coral colonies (n=2,899) within the system hosted *C. delitrix.* Sponge prevalence was coral species-specific and linked to coral defense capabilities, where *S. siderea* and *O. faveolata* exhibited the highest and lowest prevalence, respectively. *C. delitrix* prevalence was also positively correlated with both coral size and density. In contrast, no effects of patch depth and size or tourist-induced nutrient loads on sponge prevalence were found. Our snapshot study provides a unique perspective on factors influencing *C. delitrix* prevalence and is the first to highlight the role of colony size in explaining prevalence by the sponge.

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OP4-S3 The role of aquariums to fill knowledge gaps for sharks and rays

Sharks and rays are highly threatened, the dire conservation status of these species is due to overexploitation either directly targeted or as bycatch in global fisheries. Although most species are harvested through bycatch, it is usually highly valuable bycatch due to the high value of the fins and other products in the domestic and international markets. To regulate the international trade of sharks and rays, the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) lists 5.7% of the described species. To inform policymakers, management authorities, aquarium curators, and conservation practitioners, we have collected data on six parameters to identify knowledge gaps for sharks and rays. This project shows for each of the 1226 Elasmobranchs species, the available information, international legislation, and other critical data for their conservation and management. These include the species extinction risk, products and volumes traded internationally and the catch reports from global fisheries. Our results show that 88.5% of the species are not protected by any of the five international conventions analyzed and substantial knowledge gaps to improve management decisions. Aquariums in the Species360 global network have 11% of the described shark species and 13% of the described ray species under their care. Aquariums house 13 threatened shark species and 29 threatened ray species worldwide, including the most traded shark and ray and other important species that could serve as vital insurance populations for conservation efforts. In this study, we show the critical role of aquariums to support policymakers and conservationists to make decisions for many at-risk species.

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OP5-S3 What's left in the tank? Identification of aquarium's coral collections with DNA barcodes as part of an integrated diagnostic approach

The unprecedented threats to coral reef ecosystems from global climate change (GCC) require an urgent response from the aquarium community, which is becoming an increasingly vital coral conservation resource. Unfortunately, many hermatypic corals in aquaria are not identified to species level, which hinders assessment of their conservation significance. Traditional methods of species identification using morphology can be challenging, especially to non-taxonomists. DNA barcoding is an option for species identification of Scleractinian corals, especially when used in concert with morphology based assessment. This study uses DNA barcodes to try to identify aquarium specimens of the diverse reef-forming family *Acroporidae* from hundreds of samples across seven institutions, while highlighting the shortcomings of the state of the art. We identified to species name 44% of the analysed samples and provided provisional identification for 80% of them (in the form of a list of species names with associate confidence values). We highlighted a sampling bias in public nucleotide sequences repertories (e.g.: GenBank) towards more charismatic and more studied species, even inside a well-studied genus like *Acropora*. In addition, we showed a potential "single observer" effect with over a quarter of the reference sequences used for these identifications coming from the same study. We propose the use of barcoding and query matching as an additional tool for taxonomic experts and general aquarists to increase their chances of making high confidence species-level identifications. We produce a standardised and repeatable methodology to increase the capacity of aquariums and other facilities to assess non-ascribed species.

Oscar Franken (1), Sander Holthuijsen (2), Sterre Witte (2), Jon Dickson (2), Katrin Rehlmeyer (1), Kasper Meijer (1), Quirin Smeele (3), Han Olff (1), Tjisse van der Heide (1,2) and Laura Govers (1,2)

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OP6-S3 Wadden Mosaic: Understanding the ecological functioning of the subtidal Wadden Sea

The Wadden Sea is of great ecological importance and supports many species of birds and fish. These species depend on a plethora of benthic invertebrate species living in and on the sediment. While the intertidal mudflats are relatively well studied, the biodiversity and food web structure of the subtidal Wadden Sea is relatively unknown. It is thought that the sea floor once consisted of a diverse mosaic of sand, silt, boulders, mussel beds, shells, seagrass beds, flat oysters and other structures, but there are indicators that this mosaic has become more homogeneous over time. Over the course of the next four years, the Wadden Mosaic project aims to shed light on this hidden part of the Wadden Sea. We will map biodiversity and link the benthic communities to habitat characteristics. In addition, we will test the feasibility and iii) testing restoration possibilities of subtidal seagrass meadows and iv) testing the effectiveness of excluding bottom trawling fisheries from marine protected areas. Here, we will present the first results from a large sampling campaign of 1394 boxcore samples, which were taken in a sampling grid throughout the whole subtidal Dutch Wadden Sea. Overall, the results from the project will improve

our understanding of the ecological functioning of the subtidal Wadden Sea, and predict the effectiveness of management practices aimed at sustaining or increasing biodiversity.

Sterre Witte (1), Jon Dickson (1), Sander Holthuijsen (1), Katrin Rehlmeyer (2), Han Olff (2), Laura Govers (2,1), Oscar Franken (2,1) and Tjisse van der Heide (1,2)

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OP7-S3 Restoration potential for subtidal shellfish populations in the Dutch Wadden Sea using hard substrates

Coral restoration & marine conservation known about the critical factors for restoration of subtidal shellfish beds. This study therefore examines the potential of restoring shellfish beds in the subtidal Wadden Sea, with a focus on reef building oyster and mussel populations. In a first exploratory field experiment, six different types of natural or biodegradable settlement substrates for shellfish recruitment are tested and compared in both the Eastern and Western Wadden Sea. Additionally, the role of differences in substrate complexity in recruitment of shellfish is evaluated using 3D printed structures with varying standardised habitat complexity. Differences in settlement success between the types of substrates are evaluated, to decide which show the highest potential for scaling-up to larger scale restoration projects in order to contribute to science-based management decisions.

Session 4 - Fjord systems: Ecology, bentho-pelagic coupling, and anthropogenic impacts

Session host: Thomas Heran (1,2) and Santiago E.A. Pineda-Metz (1,2)

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Fjord systems have been carved by extreme forces of nature, resulting in a complex geography of channels, islands, and islets. Here, pronounced physical and chemical gradients overlap (e.g. tide and salinity), forming an intricate pattern with multiple combinations. These overlaying sets of factors shape many unique habitats and niches for marine organisms, resulting in a hotspot of biodiversity due to the elevated species richness, both benthic and pelagic.

Here, as in any other marine ecosystem, benthos and pelagos are connected via processes where matter is exchanged between them. An example in fjord system can be found in habitat-forming and sessile species such as cold water corals. These corals are suspension feeders which capture zooplankton and suspended detritus, thus strengthening the bentho-pelagic coupling by enhancing carbon and nutrient fluxes from the pelagic to the benthic realm.

Fjord systems have been exposed to recent significant anthropogenic climate change and other man-made pressures such as fishing, aquaculture and dams. Due to the lack of ecological and environmental knowledge of these systems, the extent of the impact is far from known.

Thus, this session aims to present recent findings in terms of fjord dynamics by including, without being restricted, to topics such as (1) fjord ecology and its relevance to mitigate global warming, (2) anthropogenic and environmental threats to the fragile fjord ecosystem, (3) life history of a fjord specie,

and (4) seasonal dynamics in fjords. We expect this session to be especially interesting for scientist focused on fjord ecology, but also for all the scientific community working in key species and oceanography within fjord ecosystems.

We expect this session to include multidisciplinary scientific approaches, showing the interconnectivity between biotic and abiotic characteristics of fjord systems.

Claudia Elena Schmidt (1), Helmuth Thomas (1), Daniel Pröfrock (1), Chantal Mears (1,2), Torben Stichel (3), Grit Steinhöfel (3)

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OP1-S4 Exploring Rapid Changes in the Arctic Ecosystem – First ECOTIP expedition to the Kongsfjorden on Svalbard

The Arctic Ocean and its adjacent seas are especially vulnerable to climate change. Its ecosystem is rapidly changing in response to temperature increase, loss of sea ice, and the combined effects of additional stressors such as invasive species and pollution. However, the scientific community currently lacks sufficient information on the mechanisms, drivers and thresholds of these environmental changes on the Arctic ecosystem and the consequences that may arise for many Arctic communities. The recently launched ECOTIP project aims at closing these knowledge gaps by investigating the impacts of climate change on the Arctic marine environment in order to identify tipping points that can induce an abrupt and sometimes irreversible change in the ecosystem. In a joint sampling campaign between the Helmholtz Centre Geesthacht (HZG) and the Alfred Wegener Institute (AWI) water and sediment samples from key marine and terrestrial locations in the Kongsfjorden area on the west coast of the Svalbard archipelago were collected in July 2020. The aim of the ongoing study will be to understand the mechanism of carbon cycling in a polar fjord system that is influenced by profound environmental changes by measuring alkalinity and dissolved inorganic carbon (DIC). Furthermore, the biogeochemical cycle of metals, trace metals and other elements in coastal and shelf waters influenced by melt water streams, draining from land terminating glaciers, will be investigated by multi-element analyses. The collected data will provide scientific insight into biogeochemical processes in high-latitude fjord and coastal regions affected by climate change and thus help to predict future changes in Arctic ecosystems.

Elena Popova (1)

1 All-Russia Scientific Research Institute for Geology and Mineral Resources of the Ocean (VNIIOkeangeologia), Saint Petersburg, Russia

OP2-S4 Compilation of datasets on heavy mineral content in surface sediments of the Eurasian shelf of the Arctic Ocean

Long-term research of the seas in the Eurasian part of the Arctic shelf by VNIIOkeangeologia for mapping resulted in an accumulation of data on the heavy mineral composition of the surface sediments. Merging more than 15 datasets on separate water areas to a single dataset allowed seeing and analyzing the distribution of heavy minerals in sediments similar to earlier works of Vogt (1997), Kosheleva (1999), Stein (2008), and others.

Many factors influence the composition of the sediments in the Arctic Ocean: climate, currents, morphology, riverine input, geology. Heavy minerals, coming from the continent and being resistant to long-distance transport, can indicate the riverine input and reflect the geology of the source rock clearly. As the river runoff into the Arctic Ocean is especially large (Aagaard & Carmack, 1989), the input of heavy minerals is increased.

The samples, more than 2000, taken from the area of all Eurasian shelf seas are joined with the data points from PANGAEA which covered also parts of the Atlantic Ocean and central part of the ocean; the seas are studied more closely. Maps of the distribution of major or significant minerals are created using ODV (Schlitzer, 2020) and ArcGIS.

The seas are compared in terms of prevailing minerals and associations. Calculation of maturity indices, such as ZTR (Morton & Hallsworth, 1994), is performed to better track the source areas. Based on data on the mineral content in the surface sediments, the associations of minerals depending on geography are distinguished making it possible to trace the relationship between the composition of sediments and the geology of the continent. In studies on mineral distribution the provinces are usually drawn within the sea (Kosheleva, 1999; Gurevich, 2002); in this work, the larger scale is considered thus allowing seeing the greater picture of Eurasian rivers' input of components.

Kai-Frederik Lenz (1), Catalina Gebhardt (2), Arne Lohrberg (1), Florian Riefstahl (1,3), Orlando Martinez (1) and Bautista1 and Felix Gross (1,4)

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OP3-S4 Glacial dynamics of the Laurentide Ice Sheet along a terrestrial-to-marine transect in East Canada

The eastern Canadian margin off Labrador is one of the key areas of Cenozoic to present climate change. The Atlantic meridional overturning circulation (AMOC) is a key factor in this region. During glaciations, vast areas of Northern North America were covered by thick ice sheets such as the Laurentide Ice Sheet (LIS). In periods of melting, these ice sheets released significant amounts of freshwater into the North Atlantic and significantly altered the ocean circulation. Open questions concerning the effect of global warming on the AMOC drive discussions and studies on the mechanisms responsible for the change in ocean circulation. As changes in the AMOC were mainly caused by natural climate fluctuations between glacials and interglacials, it is critical to examine the dynamic behavior of the LIS in detail. However, information from the shelf, coastline, or Canadian interior is limited to (i) studies of postglacial sediments from the Labrador shelf and adjacent inlets, and (ii) dating of currently exposed geomorphological features on land that have likely formed during the last glaciation. Lakes, fjords and inlets on the Canadian shield have long been considered as having been excavated by glaciers completely during the Wisconsin glaciation, hence holding sediments of glacial and post-glacial age, but not from before the last glacial. During the past few years, we carried out a series of expeditions to the Labrador Shelf (marine), Lake Manicouagan (terrestrial) and Lake Melville (marine/lacustrine) to study the dynamic behaviour of the LIS making use of a combination of bathymetry, sediment echosounding, and 2D high-resolution seismics. We discovered landforms likely related to the penultimate and older glaciations as well as sites consisting of thick sediment packages that have likely formed before the Wisconsin glaciation. The new data will

provide new important constrains for the reconstruction of the LIS evolution along this terrestrial-to-marine transect.

Session 5 - How do marine key species respond to a rapidly changing environment?

Session host: Jan Phillipp Geißel (1)

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Climate change and anthropogenic stressors pose a variety of threats and challenges to key species forming ecosystems, food webs and creating habitats. In our rapidly changing world sea surface temperature rises, sea ice cover declines, CO_2 partial pressure rises, ocean pH gets reduced, and many more changes emerge. Other relevant stressors possibly discussed in this session are light and noise pollution, and hypoxia.

Understanding how key species are affected by these changes and might respond and adapt to them is crucial to predict ecosystem changes, to understand cascading effects following from these changes and to allow informed mitigation and advice decision-makers.

Therefore, this sessions aim is to collect contributions from the disciplines that investigate the effects of environmental alterations on the first line of response in animals, namely: physiology, ecophysiology, behavioural physiology, conservation physiology and neuroecology. Getting a better understanding of the underlying physiological mechanisms (e.g. acid-base regulation, metabolic regulation, respiration, acclimation and adaptation) in response to environmental stressors will allow a better base for modelling and understanding trends in population abundance, stock and population declines.

This stated it appears crucial to highlight current research on these topics conducted not in model species but key species of respective ecosystems. Work presented in this session can cover key species from all animal taxa and all ecosystems.

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OP1-S5 Responses of antipatharians to heat-stress: and eco-phyisiological study on a mesophotic species from French Polynesia

Antipatharians, also known as black corals, are widely distributed ahermatypic hexacorallians that form dense populations providing structural habitat for many species. Despite being an integral part of reef communities, they have been far less studied than scleractinian corals, due to technical and practical limitations. Most studies to date have been conducted on shallow- water populations (<50 m) and studies dedicated to the basic biology of antipatharians are scarce. Particularly, their response to global change stressors remains totally unexplored.

Therefore, the present study assessed the effects of heat stress on a mesophotic (70-90 m) *Stichopathes* species from French Polynesia. Nubbins were maintained for 16 days at four different temperatures

(control, +1.5°C, +3°C and +4.5°C), selected according to the natural variability of the environmental conditions retrieved from data loggers deployed during two months. Respiration, excretion, survivorship, healing capacity, mucocyte tissue density and antioxidant responses were measured and analysed by regression methods.

Oxygen consumption and healing increased with temperatures up to a tipping point temperature around 28.7°C, after which they sharply decreased. However, tissue necrosis and mucocyte tissue density increased continuously with temperature. Altogether, these results demonstrate that antipatharians could be able to cope with moderately increased temperature but that values expected for the end of the century could be beyond their acclimation abilities.

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OP2-S5 Survival and larval development of two crab species: exotic *Hemigrapsus sanguineus* and native *Carcinus maenas*

Quantifying species responses to the combined effects of multiple environmental conditions is critical for a better understanding of the effects of climate change on expansion and contraction of coastal-estuarine species. Climate change is leading to modifications in the coastal environment, to conditions not experienced before; however, those changes may operate differentially on native and exotic species. We compared the effects of temperature and salinity, on the larval survival and development of a recently introduced Asian shore crab (*Hemigrapsus sanguineus*), co-occurring with the native European shore crab (*Carcinus maenas*). *H. sanguineus* limits recruitment of *C. maenas* and predate on their juveniles; but there is little information on the performance of their larval stages, needed to understand the effects of climate change on recruitment and connectivity. Freshly hatched larvae of both species were reared from hatching to the megalopa at different combinations temperature (range: 12-24°C) and salinity (20, 25 and seawater = 32.5 PSU). In both species, larval performance was favoured at temperatures ≥18°C: larvae grew faster and reached megalopa in higher proportions, with little effect of low salinities. However, at low temperatures larvae of *C. maenas* had a better performance than those of *H. sanguineus*, especially at low salinities. Our results suggest that advantages given by tolerance to low temperature and salinity in *C. maenas* larvae will banish as temperature increase, shifting further the balance towards the establishment *H. sanguineus*.

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OP3-S5 Helgoland's lobster restocking stunted by future climate scenario?

Climate change combined with anthropogenic stressors (e.g. overfishing, habitat destruction) may have particularly strong effects on threatened populations of coastal invertebrates. Around the island of Helgoland, the collapse of the local population of European lobster (*Homarus gammarus)* prompted a large-scale restocking program. The question remains if recruitment of these program-released specimens could be hampered by ongoing climate change. We examined the joint effect of ocean warming and acidification on the survival, development, growth, energy metabolism and stress responses of early larval

stages European lobster. Larvae were reared from stage I to III under a factorial experiment consisting of ten different seawater temperatures (12-24°C) combined with ambient (410 ppm) and elevated (1100 ppm) seawater pCO_2 treatments. Physiological responses to the joint effect of high pCO_2 and temperature changes was assessed by measuring the enzyme activity of four enzymes (superoxidase dismutase, catalase, glutathione-s-transferase and glutathione peroxidase) against oxidative damage (lipid peroxidation using malondialdehyde as proxy). An integrated biomarker response approach was used to visualize the stress response to elevated pCO_2 treatments across the experimental temperature gradient. Larvae in CO_2 – acidified seawater had lower survival rates and significantly smaller rostrum, eyes and telson. However, development time and oxygen consumption was unaffected by high pCO_2. Oxygen consumption rates increased with increasing seawater temperature, while development time decreased. Enzyme activity differed between ambient and high pCO_2 treatment in larvae reared in temperatures below 17°C degrees and over 19°C. At these temperatures, larvae under elevated pCO_2 treatment, enzyme activity was lower, possibly exposing the larvae to further oxidative damage. These results provide an insight on the aerobic thermal window of lobster larvae and how exposure to hypercapnic seawater future scenarios may narrow it, thus potentially having repercussions for the lobster fisheries.

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OP4-S5 Recent shifts in the zooplankton community in the inshore Western Baltic Sea and potential consequences of herring (Clupea harengus) recruitment

Existing data demonstrate strong effects of climate change on plankton communities that can result in decline of energy availability for predators. Energy availability can be altered by decrease in zooplankton quantity, change in species composition and spatial or temporal mismatch. The present study investigates zooplankton prey field for herring larvae in the

Greifswald Bay where a major component of Western Baltic spring-spawning (WBSS) herring performs annual spawning migrations. Monitoring programs have shown a decreasing trend in WBSS herring recruitment over the last two decades. To determine if this trend is potentially

caused by changes in the preyscape, we analyse a 12-year data series of weekly zooplankton abundance and species composition. Our data show that zooplankton abundance has decreased 10 times since 2008. In addition, we find that the zooplankton size fraction available to first feeding herring larvae often does not reach the critical threshold density to initiate first feeding. Future time series analyses of the zooplankton will relate our findings with biotic and abiotic factors to explain the zooplankton decrease through bottom up and top down controls.

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OP5-S5 Exploring Possibilities for Subtidal Seagrass Restoration

Seagrasses are important foundation species which provide a multitude of ecosystem services, such as enhancing water clarity and sediment stability, and increasing biodiversity. In the past, extensive subtidal meadows grew in the Dutch Wadden Sea. However, in the 1930s, the wasting disease caused a sharp decline of eelgrass (Zostera marina) populations throughout Europe. Construction of the Enclosure Dam in the early 1930s drastically shortened the Dutch coast line and led to great manipulations of hydro- and sediment dynamics. Until present, subtidal eelgrass did not manage to recolonize its former habitat in the Dutch Wadden Sea. Restoration of subtidal seagrass might increases biodiversity, as the meadows provide shelter and nurseries for fish and other species. Environmental conditions in areas where historical seagrass occurred changed greatly. Therefore, locations of historical meadows may no longer be suitable for subtidal eelgrass. In order to avoid trial-and-error based restoration attempts in which seagrass is planted at unsuitable sites, consensus forecasting by modelling is crucial. Environmental parameters that can avert seagrass survival are for instance poor light conditions, and high hydrodynamical stress. We therefore aim to construct a habitat suitability map using a combined approach of measuring environmental conditions in situ, combined with literature analysis and statistical modelling. For the actual measurements, we selected nine locations in the Dutch Wadden Sea, where we continuously (year-round) measure parameters such as temperature, light availability, sediment movement, current flow velocities, along with wave and water level height. For this, we attached submersible sensors to measuring frames, which are currently collecting data. After one year of data collection, the frames will be moved to additional locations. We expect that, despite the continued absence of subtidal seagrass in the Dutch Wadden Sea, the suitability map will indicate potential suitable locations for restoration trials.

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OP6-S5 Effects of environmental parameters on the stable isotopic composition of pteropod shells

Fast environmental changes of the present are encouraging marine scientists to refer to the geological record of the past climates. Most paleoenvironmental reconstructions rely on various analyses of calcitic tests of foraminifera, however, they are still limited especially in regard to carbonate chemistry. Pteropods, holoplanktonic mollusks, are among first responders to the rapidly changing environment and their shells can bear valuable information for climate reconstructions. By means of stable isotope analysis of shells of five pteropod species (*Limacina helicina, L. trochiformis, L. bullimoides, Heliconoides inflatus, Creseis sp.*) collected during the SO264 cruise in the western Pacific over a broad range of latitudes (10°S - 50°N), we support the hypothesis that pteropods have great potential as proxy carriers for palaeoceanographic research. Calcification depths of all investigated species were deduced to be within the upper 100 m even for specimens collected from deeper waters. Although estimated calcification depths varied latitudinally with tendency to be shallower at higher latitudes, it was consistently associated to the depth of chlorophyll maximum. Negative linear relationship between δ18O of pteropod shells and ocean temperature as well as negative linear relationship between δ13C of pteropod shells and carbonate ion concentration were established. As interspecific variations could not be determined, the resulting calibration equations based on data from all five investigated species, represent a generalized view on the use of pteropods as proxy carriers for NW Pacific, and provide evidence for their excellent suitability for palaeoceanographic research.

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FP1-S5 Investigating the interactive effects of irradiance and warming on *Laminaria* kelp species

Global oceans are currently changing at a faster rate than at any other time over the last 300 million years. Temperature is a key driver of biochemical and physiological changes and rapidly increasing temperatures are impacting marine species globally. It does this by altering species abundances and distributions, increasing extinction risks, consequently impacting population structure, community composition, and species interactions. Here, we investigate the effects of temperature and light levels (which are dependent on competition) on the physiological responses of kelp of three important *Laminaria* species (*L. digitata, L. hyperborea, L. ochroleuca*) found in the Southwest UK. Juvenile kelp were maintained under six different experimental regimes consisting of three temperatures (ambient, +2, +5) and two light levels (high and low irradiance). Measures of growth and photosynthetic performance were recorded over a month-long period. Kelp are important foundation species of cold water and temperate habitats, supporting a high level of biodiversity, as well as having high economic value. Understanding how these species respond physiologically and how their interactions shift with temperature will help us predict how populations may be affected by changing climate and consequently how the structure and function of ecosystems may be impacted in a future ocean.

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OP7-S5 Analysis of the effect of shoot density on metabolism and dissolved organic carbon fluxes (DOC) in seagrass communities

Seagrass communities are one of the most important ecosystems for the balance of coastal areas due to the wide range of services they provide, particularly by their high productivity. However, they are among the most threatened ecosystems. The partial or complete loss of shoot density are mainly due to the result of the uncontrolled coastal development, as well as climate change, both derived from anthropogenic pressures. The main goal was to study how the regression of seagrass communities could alter the carbon metabolism and dissolved organic carbon (DOC) fluxes. To do that, a medium term (3 months) in situ manipulation of shoot density was performed on healthy and well-developed populations of *Cymodocea nodosa* (i.e. treatments 100, 60 and 25% of natural density) at two contrasting seasons (winter and summer). The experiment was carried out in situ using incubation chambers, which allowed to monitor variables at the community level such as carbon metabolism, DOC fluxes, fauna assemblages and sediment organic matter and chlorophyll a contents. The results showed significant changes in both individual and community-level variables in the experimental plots where shoot density was reduced. The community net productivity and DOC fluxes decreased significantly when shoot density was reduced, shifting from an autotrophic community to a heterotrophic one in winter. Fauna abundance decreased significantly in winter as shoot density was reduced, meanwhile algae abundance raised, although no significantly, in both seasons. Density reduction significantly decreased the organic matter in the sediment during summer, in contrast, there was not a clear trend in the chlorophyll a concentration. In conclusion, this study highlighted how the degradation of a seagrass population (i.e. reduction in shoot density)

caused large changes at the community level, which was mainly acute in the carbon metabolism and DOC fluxes at the community level.

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OP8-S5 Effects of an in situ-simulated marine heatwave on carbon metabolism and dissolved organic carbon (DOC) in coastal vegetated communities

Coastal vegetated communities rank among the most productive ecosystems worldwide, as well as among the most threatened by climate change effects. One of these effects is the increase in frequency, intensity and duration of extreme climatological events such as marine heatwaves (MHW). This work explores the consequences of an in situ simulated MHW in two benthic vegetated communities, one dominated by the seagrass *Cymodocea nodosa* and another dominated by the macroalgae *Caulerpa prolifera*. In order to do that, during the summer season benthic chambers for control (CT) and high temperature treatments (HT) were placed on the meadows. The latter were equipped with heaters to simulate MHW conditions, eventually achieving a temperature increase of 3.3 oC respect CT for a duration of 72h. The effects were studied at organism level, analyzing physiological changes in the dominant macrophyte of each meadow; and at community level, studying shifts in the carbon metabolism and dissolved organic carbon (DOC) fluxes within the communities. The results showed decreases in non-structural carbohydrates (NSC) in the dominant macrophyte of both communities subjected to HT treatments, especially in *C. nodosa*. The simulated MHW enhanced the productivity and DOC release of the community dominated by *C. nodosa*, whereas the community dominated by *C. prolifera* decreased its production and acted as a net DOC consumer. At organism level, this work suggests that in a future scenario, *C. nodosa* would be more sensitive to the stress produced by more frequent, longer and intense MHWs than *C. prolifera*. At community level, the seagrass community would enhance its carbon contribution to food webs, the export of organic matter to adjacent communities as well as their carbon sequestration capacity. On the contrary, these ecosystem services would be more limited in the macroalgae meadow, which would be at disadvantage and might eventually reach a heterotrophic condition.

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OP9-S5 Thermal anomalies trigger phenological shifts in Mediterranean threatened marine forests

Fucoid algae of the genus *Cystoseira* are keystone species in the Mediterranean Sea. They form dense forests, creating habitat for rich associated biota and playing a crucial role in primary production and nutrient cycling. In the last decades, these species have been declining/lost in many areas, due to the interplay of several direct human impacts on the coastal environment and climate change. In the Northern

Adriatic Sea (NE Mediterranean), the abundance and distribution of Cystoseira barbata has notably decreased in the last thirty years, and only a few populations still thrive. Despite extensive monitoring, the species was not found fertile in 2017 and 2018, while it was found fertile twice in 2019: the first time in winter, prematurely, after a marine heatwave, the second time in spring, when it usually reproduces. This thermal anomaly caused a phenological shift, affecting the morphology of thalli throughout the whole reproductive season. After the heatwave, thalli showed a winter habitus with small receptacles growing on adventitious Fucoid algae of the genus Cystoseira are keystone species in the Mediterranean Sea. They form dense forests, creating habitat for rich associated biota and playing a crucial role in primary production and nutrient cycling. In the last decades, these species have been declining/lost in many areas, due to the interplay of several direct human impacts on the coastal environment and climate change.

In the Northern Adriatic Sea (NE Mediterranean), the abundance and distribution of *Cystoseira barbata* has notably decreased in the last thirty years, and only a few populations still thrive. Despite extensive monitoring, the species was not found fertile in 2017 and 2018, while it was found fertile twice in 2019: the first time in winter, prematurely, after a marine heatwave, the second time in spring, when it usually reproduces. This thermal anomaly caused a phenological shift, affecting the morphology of thalli throughout the whole reproductive season. After the heatwave, thalli showed a winter *habitus* with small receptacles growing on adventitious branches. In spring, thalli showed not well-developed primary branches with small receptacles.

To assess the effects of the phenological shift triggered by the heatwave on reproductive biology and early post-settlement and juvenile stages of *T. barbata*, both times receptacles were sampled, and release efficiency and germling growth were assessed in culture. Receptacles sampled in spring released 10 times fewer zygotes and, after four weeks in culture, germlings were 4 times shorter than during the previous exceptional event in winter. Growth was consequently affected also later in the field after outplanting.

This is the first time the effects of a phenological shift in response to a thermal anomaly have been detected for a seaweed. These observations highlight the potential disruptive effects of winter heatwaves on reproductive timing, recruitment, and survival that could severely affect the persistence of *Cystoseira* populations.

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OP10-S5 Analysis of relationship: A whale shark appearances trend in Bayeman, Prolingo waters with SST and Chl-a distribution

Whale Shark (Rhincodon typus) is one of the largest fish species that have been fully protected in Indonesia and are included in CITES Appendix II. This largest fish is unique, because they eats phytoplankton in the sea. Therefore, the appearance of these fish is an indication that the waters are experiencing an increase in nutrition. So in this study, an analysis of the trend of its appearance will be carried out with the water conditions looking at the SST and Chlorophyll-a distribution. The data used in this study are primary data on the appearance of whale sharks in Bayeman, Probolinggo based on reports from fishermen and Bayeman community groups who are the target groups of BPSPL Denpasar, as well as Aqua MODIS data with 1 km resolution for SST and Chlorophyll-a in the period from October 2018 until

September 2019. Based on the results of data processing, it can be seen that the trend of whale sharks increases when entering the transitional season 2 (September - December) until entering the west monsoon (January - March) and will begin to decline in the transition season 1 and the east monsoon. If look at the SST distribution in west monsoon, there is a ranges from 27-30 degrees celsius, and the chlorophyll-a conditions are not too high, which is below the range of less than 4 mg / m3. So, that it can be seen that Whale Shark is shown in that condition in that time. In others condisiton of environment, it can be different trend of Whale Shark appearance.

Session 6 - Extracting non-renewable resources from the oceans: challenges and opportunities from the perspective of social acceptance

Session host: Roald Leeuwerik (1)

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Industrial and technological developments have greatly increased the demand for different resources, such as metals, oil and gas. During many decades, this demand could be satisfied by terrestrial reserves. However, reserves are now getting depleted and are often plagued by local (violent) conflicts, endangering the supply. These developments have reinvigorated interest in offshore reserves, which were previously deemed too costly and technologically challenging to exploit.

Currently, industries are in different stages of development. Whereas deep-sea mining is still being planned but not taking place at commercial scale, shallower waters are already being exploited (e.g. marine diamond mining in Namibia). As for oil and gas, operations are taking place in different parts of the world, such as in the North Sea and are likely to expand. In general, offshore reserves are estimated to be very promising and worth the considerable investments in terms of technology and manpower.

Looking at these developments from a societal perspective results in a plethora of interesting questions. For instance, how should we regulate the High Seas and ensure the sustainable development of extractive industries in this area? How will we protect other economic uses of our oceans, such as fisheries, when mining seems to inevitably lead to adverse environmental impacts? What environmental and ecological knowledge do we (still) need before we begin exploiting the deep-sea? How should we engage with stakeholders and is it possible to make them benefit from resource exploitation?

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OP1-S6 Conceptualising the interaction of context, process and status in the Social License to Operate tested for the case of marine diamond mining in Namibia

This research explores the Social License to Operate (SLO) in relation to seabed mining operations. The SLO has grown in importance over the years and mining companies are increasingly aware of its importance to reduce social risks. However, the SLO should not be seen as a separate entity but rather as an additional requirement next to a Legal License to Operate (LLO) and Political License to Operate

(PLO). Recognising this interaction, we developed a conceptual framework, based on - and using the work of previous scholars - the fundamental process-related factors of the SLO (trust and legitimacy), the larger context of the SLO (comprising the LLO and PLO) and the different levels of the SLO (status). Context, process and status have been combined into a conceptual framework to facilitate analysis on a case by case basis. This article presents this conceptual framework and tests the framework on the case of marine diamond mining in Namibia. The framework was found to be useful for an analysis of the SLO, particularly because the inclusion of the context increases understanding of how the manner of organising, operating etc. in LLO and PLO have repercussions for the different process-related factors of the SLO and its resulting status now and in the future. Based on our framework and its application to the case of marine diamond mining, we came up with a new definition of the SLO.

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OP2-S6 The coexisting utilitarianism and libertarianism: The socio-economic and environmental impacts in offshore tin mining management

Utilitarianism and libertarianism have come to exist on tin resource management on the Bangka Belitung Islands, given the Indonesian regime shift from centralized to decentralized authority since 1999 and 2000. In this issue, utilitarianism refers to the state-tin mining firm that possesses the largest tin deposit concession area on Bangka Belitung Islands. Its existence makes a significant contribution to Indonesian national incomes. In contrast, libertarianism represents “small-scale” tin miners whose living relied on tin ingots. Although current tin governance transformation results in diverse challenges and opportunities, the analysis of this topic is still, remarkably, few. This paper explores how coexisting utilitarianism and libertarianism in offshore tin mining creates a plethora of socio-economic and ecological impacts on the Bangka Belitung Islands.

The case study of the conducted fieldwork took place on Bangka Belitung Islands. This study relied on a qualitative research approach, including participant observation and semi-structured interviews, to gather empirical information. The researcher observed seabed tin dredging operations owned by PT. TIMAH. Besides, the researcher interviewed diverse stakeholders such as PT. TIMAH, local NGO(s), local marine ecologists, and beyond.

This paper showed that PT. TIMAH as utilitarian dredged the ocean floor to obtain the tin ingots. Its revenues contributed to national economic growth. At the same time, small-scale seabed tin miners coexisted with utilitarian to extract tin reserves for their livelihoods. Despite their contributions to the state and local economic development, local marine ecologists claimed that it had adverse ecological impacts. The sediment loads due to seabed tin dredging activities threatened (reef) fish species stock, coral reefs, and mangrove forests. The environmental issues, in turn, disturb the existing marine tourism and fisheries industry on the Bangka Belitung Islands.

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OP3-S6 The Arctic offshore production: challenges and opportunities

In a world thirsty for resources, the energy discourse has pointed out the urgency for more and diverse sources in new frontiers to keep up with the uninterrupted availability of energy sources at an affordable price. This includes extractivist spaces thought as hazardous, “empty” or wilder, e.g.: jungle, tundra, and

sea. However, this discourse has no consideration for side effects, such as: increasing pollution, oil spills, ecological interruption for the habitat on the one hand, and the unintended consequences of economic dispossession and erosion of traditional ways of life for coastal native inhabitants on the other.

The Arctic offshore production is a good case to reflect on this problematic. Due to the global warming, the ice sea cap has retreated so the deep seabed richness has been reconsidered for the ultimate economic activity in the north. Although overly ambitious, most of the offshore projects have been rejected, delayed or cancelled. Among the mainstream reasons, we can find the higher prices of production, the international oil market volatility, and the lack of technology and risk management. Aditionally, new and increasing factors on environmental protection, climate change, sustainable development, social justice, and rights of indigenous peoples are also challenging the Arctic offshore production.

Hence, the main objective of this work is to provide an energy security framework for the Arctic offshore production, rethought from a wider and inclusive perspective. My proposal considers those societal factors that have an increasing role in the Arctic energy governance. The main question to be answered is: what are the environmental and societal challenges to the Arctic energy security that should be reconsidered for the offshore production?

Session 7 - Machine learning in the marine sciences: opportunities and challenges

Session host: David Greenberg (1) and Moritz Mathis (1)

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Recently the availability of ocean and climate data has grown immensely due to significant advances in high-performance computing and observational monitoring. This opens new possibilities for understanding the dynamics and susceptibility of the Earth system, improving the predictability of future climate states and developing management strategies to ensure sustainable food and energy usage.

At the forefront of new information technologies that can benefit marine science and resource management is machine learning (ML). ML systems are applicable to a wide range of data analysis problems, such as supervised detection of data features (e.g. storms) or automatic discovery of patterns (e.g. leading variability modes in the ocean and atmosphere). ML can also be used to improve existing computational workflows, such as model parameter tuning, causal inference, sequential data assimilation and quantification of predictability and uncertainty.

However, the systems, models, and data used in marine science pose major conceptual and technical challenges for ML. Data is often irregularly structured in space or time and may have missing values, requiring standard ML techniques (such as convolutional networks) to be modified. Image-based data in the Earth sciences can reach a size and resolution seldom considered in ML, pushing existing software and hardware to their limits. When the physical systems studied and modeled exhibit both chaotic dynamic, ML algorithms based on automatic differentiation and floating point arithmetic can exhibit numerical instabilities. Overcoming these challenges is critical for realizing the full potential of ML in marine science.

This session aims at the transfer and exchange of recent ML developments, highlighting opportunities and challenges for an effective adoption of this technology across the marine sciences. We hope to bring together ML specialists interested in marine applications and marine practitioners using ML or curious

about its possibilities, promote collaborations and identify common challenges and solutions. We call for contributions that demonstrate or propose various applications of ML algorithms in the scientific analysis of marine observational products and modeling data.

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OP1-S7 Machine learning predicting pmol/g presence of TNT in a complex Baltic Sea sediment environment exclusively using microbial community composition

AbstractMicrobial fingerprints obtained by next generation sequencing provide insights into microbial functionality and their adaptive response potential. Thus, they can be used to predict distinct environmental states. Our goal was to assess the opportunities and limitations of machine learning to detect fingerprints indicating the presence of 2,4,6-Trinitrotoluene (TNT) in southern Baltic Sea sediments.

Over 40 environmental variables including the grain size distribution, the elemental composition and the concentration of explosive compounds (mostly pmol/g levels) from 150 sediments collected at the sea-dumped ammunition site Kolberger Heide near the city of Kiel were combined with 16S rRNA gene amplicon sequencing libraries. Prediction was achieved using Random Forests; their prediction robustness was further compared to results from Artificial Neural Networks.

TNT presence was neither identified among the main drivers of the microbial community composition, nor did it correlate with heavy metal concentrations. Yet the presence of the explosive using the most important 25 genera exclusively was predicted correctly with up to 84 % balanced accuracy.

Investigating the prediction robustness, it was identified which samples and areas within the Kolberger Heide were particularly challenging for the machine learning models. This provided essential information for further sampling campaigns. Additionally, the models can be trained to predict further variables. To facilitate machine learning with microbiome data we developed the R package phyloseq2ML.

In conclusion, our results suggest that microbial communities can predict even minor influences in complex environments, demonstrating the potential of this approach for environmental monitoring. Monitoring campaigns in return could continuously provide data to improve the machine learning prediction models.

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FP1-S7 Helmholtz AI services for Earth and Environment: Sharing first insights

The Helmholtz AI platform was created by the Helmholtz Association to foster the uptake and exploitation of Artificial Intelligence (AI) and Machine Learning (ML) methods for practical benefit and front-line research across scientific domains. More specifically, the Helmholtz AI Consultant Team hosted at DKRZ

serves the needs of scientific users in the thematic area of Earth and Environment who wish to explore and apply advanced methods from the areas of AI and ML.

The presentation will provide an overview of the services offered by the team, which cover a wide range of tasks from software engineering to consultation and training. For instance, the team can support you as domain scientists in defining and prototyping ML applications on problem statements and data you provide; scaling up your codebase from single machines to parallel execution on clusters and GPUs; improving your artificial neural network architectures and performing hyperparameter tuning; introducing you to ML frameworks (PyTorch, scikit-learn and Keras); and processing large amounts of data with Python packages such as Dask and xarray. DKRZ also offers computational resources that can be used for ML applications. The presentation will give insight into concrete use cases and first experiences made in practically applying ML methods, covering applications in marine sciences and earth observation.

Access to these services is free for Helmholtz researchers - we are here to help you make the most of the new methods!

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OP2-S7 Towards improved European summer climate predictions with neural networks

Current state-of-the-art dynamical seasonal ensemble prediction systems (EPS) still show limited skill, particularly over Europe in summer. We propose a neural network-based classification of individual ensemble members to target windows of opportunity emerging from large-scale atmospheric regimes associated with the dominant modes of summertime low-frequency variability in the North Atlantic-European sector (NAE). This classification leverages the ensemble prediction by taking as subsampling criteria the representation of the summer North Atlantic Oscillation (SNAO) and East Atlantic Pattern (EAP). Our baseline is a continuum of teleconnection patterns in NAE classified by Self-Organising Maps (SOM) using ERA-20C reanalysis data. We illustrate our methodology with an example with one set of hindcast ensemble simulations with 30-members generated by the MPI Earth System Model. We achieve better predictive skills at 3-4 months lead time for sea level pressure and geopotential height anomalies at 500 hPa.

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OP3-S7 Deep learning based spatio-temporal interpolation of FESOM-derived Sea Surface Temperature fields

Interpolation of ocean variables is the challenging task in climate science. Interpolation produces continuous surface data based on point data. The recent applicability of deep learning has led to

handle increasing data collections in oceanography. In particular, FESOM2 provides a breakthrough in establishing an unstructured-mesh model as the best tool in climate research. FESOM2 formulated on unstructured 2D triangular meshes, it computes Sea Surface Temperature (SST) which is a key variable that governs complex interactions between atmosphere and ocean. However, physics-based models are complex, require huge amounts of memory to store data and need high-performance computing resources. Deep learning offers opportunities to significantly improve the computational efficiency of climate models and associated workflows.

We introduce our recent efforts to reduce the storage required for ocean simulations by developing statistics emulator for spatio-temporal interpolation of FESOM-derived sea surface temperature with 15km-horizontal resolution at 5days-timesteps. We aim to develop an algorithm which is able to interpolate SST at middle timestep with high accuracy. We developed Deep Neural Network (DNN) and 1D Convolutional Neural Network (Conv1D) to examine data-driven approaches on physical variables. In these proposed NNs, sst value of nodes and its neighbors at before and after timesteps are given as input to an end-to-end convolutional neural network which interpolates a middle timestep between them.

Our experiments show that, NN works well as an interpolation function for oceanographic data. For comparative analysis, we used metric standards MSE and Logcosh which are much lower compared to classical linear interpolation, kriging, EOF-based interpolation, etc. Conv1D with neighboring information can effortlessly detect SST variability, avoids overfitting and provides more robust results which proved to outperform machine learning state-of-the-art such as linear regression, regression tree, etc. In all assessments, Conv1D is the best choice for strong correlation between real and interpolated SST which increases storage efficiency.

Vincent Sindikubwabo (1,2), Gert Van Hoey (1), Jolien Buyse (2) and Jan Vanaverbeke (2,3)

1 Gehnt University, Belgium??????????????

OP4-S7 Predictive modelling of the abundance and biomass of functionally important species at Belgian part of North Sea

This study had the objective to model the density and biomass of functionally important macrobenthic species (*Abra alba*, *Nephytys cirrosa*, Magelona species, *Macoma balthica*, *Hesionura elongata* and *Ensis directus*) in the Belgian Part of North Sea. These species are known to be key species for five communities at Belgian Part of North Sea and have high contribution to the final score of the bioturbation potential and ecosystem functioning. In addition, the models for those species we get in this study can be applied in other EU countries, where those species occurs for facilitating the marine ecosystems management plans. We predict individual species responses, based on fifteen environmental variables. Hence, for density prediction, we tried general linear model (GLM), Poison model, general additive model (GAM) and general additive model with negative binomial distribution (GAM (nb)). For biomass we tried GLM and Transformed response general linear model (TGLM) using R software. To conclude if a model was appropriate, we checked different assumptions including normality of residuals, dispersion of predicted observation, homogeneity of variances in the models, zero inflated and nonlinear pattern of variables. We successfully predict density by using count distribution models by general additive model with negative binomial, but we didn't get a good model for biomass. The highest model predictions were achieved for *Macoma balthica*, *Ensis directus* and *Hesionura elongata* with respective percentages of 82%, 81.4% and 81%, while the least one is *Nephtys cirrosa* with 34%, (GAM (nb). But why most of the models we tried failed to predict marine benthic species ? Based on our results we listed some of

disadvantages and advantages of the employed models in ecological data prediction analysis which are useful for other marine scientists.

Jozef Skakala (1,2)

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FP2-S7 Can machine learning improve our assimilative system for marine biogeochemistry?

The purpose of this flash talk is to give an overview of the data assimilation (DA) work in marine biogeochemistry on the North-West European (NWE) Shelf. The work is a collaboration between Plymouth Marine Laboratory and the UK Met Office and is designed to support future reanalyses and operational forecasts for the NWE Shelf. I will review the strengths and weaknesses of our DA system, and I will propose some future directions on how to address the system's weaknesses. I expect machine learning to play an essential role in those future directions.

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OP5-S7 FogNet: A 3D Attention Convolutional Neural Network for Fog Prediction

The reduction of visibility adversely affects land, marine, and air transportation when considering the human and economic costs. The coastal environment, including its ports and airports, is particularly sensitive to fog. Thus, the ability to predict fog skillfully would provide tremendous utility. We predict fog visibility categories below 1600m, 3200m and 6400m by postprocessing 2-D maps of numerical weather prediction model output and satellite-based sea surface temperature using a 3D-Convolutional Neural Network (3D-CNN). The study site is the Mustang Beach Airport in Port Aransas, Texas, USA (KRAS, AirNav.com). We use KRAS measured visibility as a proxy for fog that develops over the Port of Corpus Christi Ship Channel (PCC.) Greater accuracy and skill in fog prediction over the PCC would provide significant economic benefits; the PCC is the 4th largest Port in the United States in terms of its annual tonnage. It is estimated that the cost of a fog-related PCC closure totals > 100 million USD to the local economy. The features chosen to calibrate and test FogNet originated from the North American Mesoscale Forecast System (NAM) from 2009-2020, with the values of each feature organized on a 32x32 horizontal grid with spacing of 12-km; the sea surface temperature from the NASA Multiscale Ultra Resolution (MUR) dataset is represented as a 384x384 grid with 1 km grid spacing. The specific 3D-CNN model used in this work is based on multiscale dilated feature extraction, spectral and spatial dense blocks and also a channel-wise and spatial-wise attention mechanism to magnify the important areas in meteorological maps. The results of FogNet for 6, 12- and 24-hour lead time predictions are compared to probabilistic output from the High-Resolution Ensemble Forecast (HREF) system developed by the US National Weather Service. FogNet is compared to HREF predictions using 8 standard evaluation metrics.

Session 9 - Open session

Session host: Mariana Hill-Cruz (1)

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The marine science is one on of the current widest field of studies. Addressing such a large and complex system requires the study of the geology and geomorphology of the ocean floor; the physics that govern the water circulation and its relationship with the atmosphere; the biogeochemistry of the water and the cycles of carbon and nutrients; the marine ecosystems which comprise from the virus and bacterias to the largest living creatures in the planet, and even the policy that is involved in their management. At the YOUMARES conference, we recognise the importance of all these topics; therefore, the „Open session“ was offered for participants whose talk does not fit in any other session.

Moritz Baumann (1), Allanah Paul (1), Jan Taucher (1), Joaquin Ortiz Cortes (1) and Ulf Riebesell (1)

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OP1-S9 Effect of different rates and modes of artificial upwelling on particle flux and potential POC deep export

To counteract climate change, techniques to actively remove carbon dioxide from the atmosphere are required, since the reduction of global emissions alone will not suffice. Artificial upwelling has been discussed as one such technique with the potential to store additional carbon in the ocean. Bringing up nutrient-rich deep water to the surface enhances new production, thus potentially strengthening carbon sequestration. In this study we tested the effect of different rates and modes of artificial upwelling on export production and potential carbon sequestration. We conducted a five-week mesocosm experiment off the coast of Gran Canaria in 2018. The mesocosms were fertilized with different amounts of deep water. One group received the deep water in continuous additions throughout the experiment, the other received one pulse at the beginning of the experiment. We found that the amount of deep water added correlated positively with primary production rates and amount of settling particles. The pulsed addition lead to a post-bloom particle settling event characterized by more carbon rich particles (C:N ratios ~10-12), whereas the continuous upwelling simulation caused a more constant particle flux with slightly lower C:N ratios (8-9). The carbon specific remineralization rate of sinking particles increased with upwelling intensity. This counteracted the positive effects of increasing particle flux and C:N ratios on potential carbon sequestration. Our study thus showed that artificial upwelling seems to have ambiguous effects on the export and carbon sequestration potential of pelagic communities. However, since our study design focused on surface processes (0-15 m), we could not reliably assess the carbon export to the meso- and bathypelagic zones. To do so, a field study investigating the quantitative export response to artificial upwelling is needed.

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OP2-S9 The vertical biological particle transport derived from drifter samples in the northern and southern Benguela Upwelling System

The Benguela Upwelling System (BUS) is the most productive eastern-boundary upwelling system in the world oceans. With an estimated mean annual productivity of 0.37 Gt C yr^{-1} , large amounts of inorganic carbon are transformed into organic carbon and exported through the so-called biological carbon pump. Recent studies have revealed, however, that the northern BUS acts as a source for CO_2, whereas the southern BUS is considered as a sink for CO2. Yet, little is known about the functionality of the carbon pump in the BUS, especially about the relevance of actively migrating organisms in comparison to the passively sinking organic matter (marine snow). Within the research project TRAFFIC (Transfer efficiency in the Benguela Current) conducted during Meteor cruise 153 in February/March 2019, we deployed four floating sediment traps in order to collect detailed samples for deciphering the transfer efficiency in the food web of the BUS. Our first results indicate that the C/N ratios (according to the Redfield Ratios for marine Plankton) are higher in the sBUS, ranging from 6.2-12.9 and lower in the nBUS, ranging from 5.0-11.3. Similar trends are also seen in the C/P ratios, which indicate a higher efficiency to transform the nutrients in the sBUS. There is also the evidence that some key-species increase the efficiency of nutrient transformation. These results enable us to assess and to quantify the active and passive transport in the BUS and thus the mechanisms of the biological carbon pump. Detailed information about the functioning of the biological carbon pump in the BUS is crucial for our understanding of a socio-economically important region that is highly affected by an ecosystem shift in times of climate change.

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OP3-S9 Preformed nutrients: Shedding new light on oceanic carbon uptake in the Benguela upwelling system

Coastal upwelling systems are highly dynamic regions of enhanced gas exchange between the ocean and atmosphere. The Benguela Upwelling System (BUS) exhibits differences in CO_2 fluxes and has been denoted as a potential source and sink for atmospheric CO_2 in its northern (NBUS) and southern (SBUS) part, respectively. Even though studies revealed disparities in feeding source water masses, the underlying biogeochemical processes causing this opposing behavior are still not yet fully understood. Here, we present data gathered on board the R/V Meteor cruise 153 in early 2019 that first of all confirm the opposing CO_2 flux direction in the NBUS and SBUS. Furthermore, our nutrient data suggest that a significant higher share of preformed phosphate concentrations in the southern upwelling region turned the SBUS into a CO_2 sink. Additionally, the NBUS feed waters seem to have lost some of their preformed nutrients during their passage through the equatorial Atlantic Ocean so that the NBUS acts as a CO_2 source to the atmosphere. While an expected southward shift of westerly winds could potentially enhance the production of preformed nutrients in the southern ocean and their transport into BUS, we assume a strengthening of the CO_2 sink function of the SBUS.

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OP4-S9 Biogeochemistry of the Indian Ocean subtropical gyre

Oligotrophic subtropical gyres cover ~75 % of the ocean's surface and are predicted to expand under global warming and thus will become even more important for global marine nitrogen and carbon cycles. The oligotrophic Indian Ocean subtropical gyre (IOSG), however, is one of the least explored ocean regions. Our investigations provide new field data on the nutrient distribution and its isotopic composition related to the different water masses of the South Indian Ocean. Furthermore, we present first data ever measured on sediment trap derived sinking particulate matter fluxes in the low productive IOSG. Nutrient distribution in the IOSG are predominantly influenced by the typical flow-system of the subtropical gyres that lead to deep thermo-, pycno- and nutriclines in the centre and thus form strongly stratified and nutrient-depleted surface waters (< 3 μmol kg^{-1} NO_3^-; < 0.3 μmol kg^{-1} PO_4^{3-} at > 300 m). Our water mass distributions based on physical water column data are combined by nutrient measurements and stable isotope data to verify nitrogen sources and transformation processes in the IOSG and across its boundaries. Our results indicate that nutrient distribution and the nitrate isotopic composition are affected by water masses of antarctic and subantarctic origin converging and mixing with water masses from the southern equatorial Indian Ocean and the Arabian Sea. In a second step, we present a five-year series of sediment trap experiments that provide new information on the nature of organic carbon fluxes, their controlling factors and on the regional and temporal gyre variability. Due to the nutrient limited conditions in the IOSG, we measured lowest ever recorded particulate organic carbon fluxes (~0.5 mg m^{-2} d^{-1} at 2600–3500 m water depth) and lowest organic carbon export efficiencies ($\varepsilon = 0.02$) world-wide.

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OP5-S9 What causes the model-data misfit of the oxygen minimum zone in the Arabian Sea?

The Arabian Sea hosts one of the thickest oxygen minimum zones (OMZ) of the world and to make reliable future predictions with models, it is crucial to represent the current status of such an ecosystem.

However, coarse global circulation models, as used for the IPCC, show generally a large model-data misfit with regard to oxygen. Therefore, a detailed comparison of models that present our present-day understanding of physical and biogeochemical processes, shall give an overview of the main model deficiencies.

We use the historical state of 10 coupled climate models from the 5th coupled model intercomparison project (CMIP5) to compare their water mass properties and the mixing behaviour with observations and refer these results to the oxygen profiles in the Arabian Sea. Grouping the data with a cluster analysis reduces the high dimensionality of the data and gives more meaningful statements.

For more than half of the models the model-data mismatch can be explained by deficiencies in the representation of the circulation and water mass mixing processes. In the other simulations, the biogeochemical model components seem to cause the offsets.

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OP6-S9 Architecture of the Monte Amarelo flank collapse deposits offshore Fogo, Cape Verde

The ongoing build-up of volcanic islands can lead to unstable edifices that might be prone to collapse. Evidence for major flank-collapse events are found onshore and offshore on a wide range of volcanic islands, such as the Hawaiian and Canarian archipelagos, suggesting this phenomena to be a common process. Such flank collapses can generate large tsunamis with potentially disastrous consequences for the population living on the islands and along the coast.

Fogo Island is situated in the southeastern part of the Cape Verdean Archipelago, about 700 km west of Dakar, NW Africa. During the Monte Amarelo event, ~ 73,000 years ago, its eastern flank collapsed into the ocean, triggering a mega-tsunami with run-up heights of up to 270 m as evidenced by dated tsunami deposits found on the neighboring island of Santiago, located ~ 60 km east of Fogo. Even though such an event likely recurs in geological rather than historic timescales, they would have devastating consequences for the population of the Cape Verdes. The scope of these consequences, however, has been difficult to assess, due to a lack of information about the nature and volume of the Monte Amarelo flank collapse deposits. During the research cruise M155 onboard R/V Meteor in June 2019, a dense set of high-resolution multichannel (MCS) seismic reflection data along with hydroacoustic data was gathered. It was thus possible to reassess the volume of failed and remobilized material associated with the Monte-Amarelo event, which significantly exceeds previous estimates. In addition, the data suggest that the collapse occurred in multiple stages. These observations are critical to better assess the hazards associated with oceanic volcanic flank collapses and thus help to protect the population of volcanic archipelagos world-wide.

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OP7-S9 The bigger the better: Gape size of Atlantic herring (Clupea harengus L. 1758) larvae determines prey utilization

Prey availability is amongst the most important factors determining survival of fish early life stages such as Atlantic herring (*Clupea harengus*). Spring spawning herring larvae grow up in coastal waters in the southern Baltic Sea. A sufficient supply of zooplankton prey is a prerequisite for larval survival. However, larval gape size determines the maximal possible prey size and therefore the proportion of suitable prey items in a zooplankton community. At the transition from yolk sac to first actively feeding, herring larvae survival particularly depends on the availability of sufficient and adequate sized prey items. High mortality rates in this stage lead into poor recruitment and therefore challenges the entire herring stock.

To determine the potential prey field and evaluate the abundance of adequate prey items for first feeding herring larvae, knowledge about larval gape size is crucial. Therefore, in this study gape size of first feeding herring larvae was measured and compared for different hatching cohorts representing the larval season. Moreover, the gape size to body length relationship was investigated. We found a gape size of 305 ±70 μm for first feeding larvae. The results indicate that larvae of early hatching cohorts that encountered lower water temperatures during their ontogeny have smaller gapes in relation to body length than larvae from later cohorts. Depending on the size spectrum of the zooplankton community and its

abundance, first feeding larvae of early hatching cohorts might be food limited. While first feeding larvae of later cohorts might benefit from a greater gape in order to forage on larger prey. Certainly, feeding on the largest prey possible is advantageous considering the net energy gain. This study contributes to a better understanding of the coastal marine food web and a potential mismatch between herring larvae and their zooplankton prey in terms of prey size.

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OP8-S9 Standard Operational Procedure (SOP) of whale shark rescue when trapped in a closed canal

Whale Shark *(Rhincodon typus)* is one of the largest fish species that have been fully protected in Indonesia and are included in CITES Appendix II. This fish has long received special attention in the world regarding the protection of populations and individuals considering that this species has a very slow growth and development rate, making it vulnerable to extinction. BPSPL Denpasar is one of the Technical Implementation Units (UPT) of the Ministry of Marine Affairs and Fisheries of Republic of Indonesia which has the implementing protection for these fish, such as data collection on appearance, rescue if stranded as well as assistance and outreach to the community. One of the main topics in this research focuses on the procedures for rescue a species of Whale Shark when these fish enter an closed canal (river or other canal). The method that will later be outlined in an SOP is a method resulting from the modification of various methods commonly used in Indonesia as an effort to save Whale Sharks, first is the physical condition of the fish such as number of tail beats per minute, fish swimming speed per minute, and alacrity, and responds to direct stimuli from the surrounding environment. Second is water conditions such as the presence or absence of food sources (small fish/ shrimp), speed current, temperature, width and depth of canals/ river. These components are then used to determine the estimated survival time of the Whale Shark as well as further rescue methods if necessary. With several considerations of these components, it is hoped that SOP can save Whale Shark stranded in a closed canal with a higher level of effectiveness can be arranged. This procedure is expected to be implemented, so that mortality can be minimized.

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OP9-S9 Kin relationships in cultural species of the marine realm: study of a matrilineal social group of Sperm Whales off Mauritius

From an evolutionary and conservation perspective, understanding the organization and the dynamic of marine mammal social groups is of first importance. Cultural transmission, genetic diversity, and life history can be affected. The study of kin relationships sheds new lights on the organization of a social group and significantly improves the understanding of social dynamic. This kind of study involves a monitoring over several years to acquire a detailed knowledge of the group and of its members, which is particularly challenging for marine mammals. Here, we present the study of a stable social group of Sperm Whales off Mauritius, using underwater observations, individual-specific identification, and an innovative sloughed skin sampling protocol. Twenty-four identified sperm whales were sampled between 2017 and 2019. The genetic profile of each individual could be defined through nuclear polymorphism analysis. Genotypes matched the identification in the field, confirming the accuracy of the sampling method. The matrilineality was confirmed by the sharing of the same mtDNA haplotype – which is rare in the Western Indian Ocean - by all individuals of the group, except one adult female. For the first time, probable first- and second-degree kin relationships were depicted in a sperm whale social group. These have highlighted the role of kinship in the social organization of such a cultural species. The average relatedness coefficient (r=0.048) was similar to the values calculated for some highly social terrestrial mammals (e.g. Asian elephants or mountain gorillas). Taken together, result of mtDNA and nuDNA polymorphism analysis highlighted a case of adoption (an adult female was not born in the group) and pointed out multiple cases of allonursing (maternal care provided by another female than the mother). Studying the possible matrilineality of Sperm Whale cultural units (i.e. vocal clans) will represent the next step of understanding.

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OP9-S9 Measuring of the bioavailable fraction of HOCs in North Sea sediment pore water: Recreation of realistic mixtures in passive dosing bioassays

The bioavailability is a key factor responsible for ecotoxicological effects of contaminants and important for risk assessment approaches since total exhaustive extractions of contaminants do not take the importance of the bioavailable fraction into account. Hydrophobic organic contaminants including polycyclic aromatic hydrocarbons (PAHs) and polychlorinated biphenyls (PCBs) are some of the most occurring organic contaminants of concern. Due to their strong hydrophobicity, HOCs have their final destination in sediment, where their ecotoxicological effects are closely regulated by sorption and thus bioavailability.

The North Sea is one of the most heavily polluted marine regions in the world. The intensive use of this marine area leads to a growing pollution of the ecosystem by chemicals such as HOCs. The mobility of HOCs, and consequently the bioavailability, depend on the porewater concentrations of these compounds. Currently, the freely dissolved concentration (C_{free}) will establish as an important endpoint for sediment

quality and risk assessment Based on C_{free}, the chemical activity (a), describing the potential for ecologically relevant spontaneous processes, was determined. The sum of activities is an indicator of the baseline toxicity potential of a mixture.

In this study, solid phase microextration (SPME) was applied to examine the spatial and temporal distribution of C_{free} of PAHs and PCBs in sediment cores of the North Sea. The chemical activities (a) were calculated to predict the baseline toxic potential of pore water. Furthermore, the ecotoxicological effects of single PAHs and realistic PAH mixtures were examined in miniaturised passive dosing bioassays representing different trophic levels. Since nominal dosing often exhibit significant losses (i.e. sorption, volatilisation), the passive dosing method was used to overcome these difficulties. In this method, PAHs are released into the aqueous medium via passive diffusion from a silicone O-ring serving as a reservoir until a thermodynamic equilibrium is reached and enables stable exposure concentrations.

Workshops

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How do we best plan an expedition to a foreign country: Dealing with troubles, collection of animals, and getting your story to be heard!

One of the greatest motivations to choose to walk the path of science is the idea of taking part in “expeditions”. Depending on your field, this is a reality that can sometimes happen very often. However, every light casts a shadow. Going on expeditions is plagued with problematic situations which one can’t always foresee. Additionally, planning an expedition comes hand-in-hand with extensive administrative tasks, which can be twice as much when planning on traveling abroad. To top it off, imagine you have to deal with collecting animals or plants, and getting them back home. The combination of the normal problems that might occur during expeditions and these additional tasks can turn going on expeditions into an overwhelming experience. Though the greatest motivation is being out there in the field, getting your data, making a story out of it and share it with your scientific peers is an extra motivation to many. Who doesn’t like to tell about the new stuff they found? A big help is to have good audiovisual data at the moment of preparing your conference presentation/poster. Without the proper audiovisual data, your story will end up being good enough only as family entertainment. Thus, the objective of the workshop is to help you set milestones for planning an expedition to a foreign country, be ready to deal with problems, and how to deal with transporting animal samples under the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES). Additionally, you will be able to acquire the basics of photography, video, and storytelling knowledge, with the aim of getting audiovisual data which helps your science and to bring it to both scientific and non-scientific diverse audiences. prompted great progress in medicine, industry, and research.

Would you like to join forces with us?

Dr. Sebastian Wagner (1)

1 Zentrum für Material- und Küstenforschung, Helmholtz-Zentrum Geesthacht, Max-Planck-Straße 1, 21502, Germany

Introduction to climate modelling: from code to simulation

The main focus of the workshop is on the introduction to climate modelling concepts including examples from climate models with different levels of complexity. In this context, the advantages and disadvantages of the different models are discussed interactively from a conceptual point of view related to the robustness of inferences that can be drawn based on simulation results.

The hands-on session is on Energy Balance Models accompanied by exercises. In the second part hypotheses on the questions of the participants will be formulated and according models will be selected specifically suited for addressing and falsifying according hypotheses. Individual scientific questions from the participants will also be addressed in the sessions. Some basic knowledge of Unix/Linux operating systems and programming languages (Fortran, Matlab, R, Python) is preferential but not essential to take part in the course. Participants are also recommended to bring a computer with access to Unix/Linux operating systems in order to participate in the hands-on sessions.

Dr. Christian Gutsche (1)

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How to talk about climate protection successfully

Do you know that? You want to get people to do something for the climate but they just don‘t. Or they have counter-arguments that might be true or leave you speechless.

Good climate communication is fact based, aims at solutions, and does mainly feel good. It is authentic and empathetic, it has a target and a target group. It names co-benefits of climate friendly behaviour. And it connects to our daily life.

In the interactive workshop, guidelines and examples for good climate communication will be presented. We will look at communicating facts, at emotions and getting into action, at targets and target groups and at resistance towards climate protection. These issues do also apply for science communication and environmental topics.

Dr. Christian Gutsche is working as climate coach and climate entrepreneur. He is a physicist and worked in material science with a focus on solar cells and batteries. Facing the climate crisis, his deep desire is to empower people to get into climate action more effectively.

Dr. Mirjam S. Glessmer (1)

1 Germany

Using social media for science communication and career advancement

This workshop consists of a short introduction to the benefits of using social media as a scientist, followed by a hands-on phase during which participants define their personal goals for online science communication, and from that goal determine their audience and their message. Examples are taken from profiles that are related to the ocean, ocean sciences or ocean scientists, especially from my own profiles. Participants leave with a clear idea of what online science communication might best suit their purposes, and how they would go about were they to start using it.

Participants are encouraged to submit specific topics that should be discussed during the workshop, for example, whether to focus on science communication or career advancement, or on a specific social media means (Instagram, Facebook, Twitter, LinkedIn).

Kristina Beck (1) and Luisa Düsedau (2)

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Scientific diving

Are you interested in diving and would like to take samples underwater yourself? Become a scientific diver! In this workshop you will learn more about scientific diving courses in Germany and abroad. Take part in this workshop if you already have diving experience or if you want to start diving and are interested in becoming a scientific diver! See you there ;)
