Workshop schedule - Morning session

How to approach interaction at spatial and temporal microscales?	Strategies for more ecological sand mining	How to use Lagrangian modelling to analyse ocean and coastal dynamics?	Eukaryotic algae for fuel or sea surface temperature proxies.	Evolution: patterns and predictions	Viruses; small biological entities that can have large ecological effects
Saara Suominen (NIOZ, OCS) Mikael Kaandorp (UU, IMAU) Divyae Prasad (UU, Bio-Info) A de Kluijver (UU, GEO) Dina Castillo Boukchtaber (NIOZ, MMB) Bastiaan von Meijenfeldt (UU, Bio-Info)	**Chiu Cheng (NIOZ, EDS)** Danghan Xie (UU, GEO) Julia Karagicheva (NIOZ, COS) Christiaan Hummel (NIOZ, EDS)	**Philippe Delandmeter (UU, IMAU)** Evert de Froe (NIOZ, EDS/OCS) Matthias Kuderer (UU, GEO) Roos Bol (NIOZ, OCS) Kristin Ungerhofer (NIOZ, OCS)	**Ruth Perez Gallego (UU/NIOZ, MMB)** Ulrike Hanz (UU/NIOZ, OCS) Tim Sweere (NIOZ, OCS) Celine van Bijsterveldt (NIOZ, EDS) Muriel Bruckner (UU, GEO)	**Bram van Dijk (UU, Bio-Info)** Alena di Primio (NIOZ, MMB) Coral Diaz-Recio Lorenzo (NIOZ, OCS) Daniele Castellana (UU, IMAU) Lise Klunder (NIOZ, COS) Nadine Smit (NIOZ, MMB)	**Ella Wesdorp (NIOZ, MMB)** Eva Deutekom (UU, Bio-Info) Siham de Goeyse (UU/NIOZ, OCS) Jildou Schotanus (NIOZ, EDS) Julian Vosseberg (UU, Bio-Info)

Exploiting the deep: How will anthropogenic exploitation of submarine canyons impact these deep sea habitats?	Glacier-ocean interactions	From field to computer, what field data do modelers need and how do we obtain it?	Predicting future sea level rise by comparing present day conditions with past analogues	Fe in the Ocean	Ecosystem self organization
Sofia Ledin (NIOZ, OCS) Haorui Peng (UU, GEO) Claudia Wieners (UU, IMAU) Milou Arts (NIOZ, MMB) Anna van der Kaaden (NIOZ, EDS)	**Alice Stuart-Lee (NIOZ, EDS)** Felix Beckebanze (UU, Math) Peter Nooteboom (UU, IMAU) Sabine Haalboom (NIOZ, OCS)	**Jaco de Smit (NIOZ, EDS)** Pieter Dirksen (UU, GEO) Marieke Laengner (NIOZ, EDS) Rick Hennekam (NIOZ, OCS) Thomas Hoyle (UU)	**Frida Hoem (UU, GEO)** Linda Dämmer (NIOZ, OCS) André Jüling (UU, IMAU) Christine Boschman (NIOZ, MMB) Bruna de Queiroz (NIOZ, COS)	**Hung-An Tian (NIOZ, OCS)** **Mathijs van Manen (NIOZ, OCS)** Ilja Kocken (UU, GEO) David Wichmann (UU, IMAU) Charlotte Eich (NIOZ, MMB) Jingjing Guo (UU, GEO) Greg Fivash (EDS)	**Roeland van de Vijsel (NIOZ, EDS)** Arya Iwantoro (UU, GEO) Ruoying Dai (UU) Gonçalo Piedade (NIOZ, MMB) Camilla Bertollini (NIOZ, EDS) Sanja Selakovic (UU, GEO)

Endophytic microbiomes of Azolla sp. ferns
Laura Dijkhuizen (UU, Bio) Maaike Goudriaan (NIOZ, MMB) Karlijn Doorenspleet (NIOZ, MMB) Jeroen Meijer (UU, Bio-Info) Indah Ardiningsih (NIOZ, OCS)

Workshop schedule - Afternoon session

Marine plastic data	Predicting the future state of the AMOC using observations of past and present AMOC variability	Large-scale and long-term simulations – How to use complex process-based models and yet obtain realistic results?	Geoengineering - a cool plan or megalomania?	Building interdisciplinary teams: A way of making better projects	Energized! Top-down bottom-up. Who drives the system the energy source or the consumer?
Mikael Kaandorp (UU, IMAU) Maaike Goudriaan (NIOZ, MMB) Jeroen Meijer (UU, Bio-Info) Laura Dijkhuizen (UU, Bio) Sofia Ledin (NIOZ, OCS)	**Roos Bol (NIOZ, OCS)** Coral Diaz-Recio Lorenzo (NIOZ, OCS) Daniele Castellana (UU, IMAU) Felix Beckebanze (UU, Math) Frida Hoem (UU, GEO)	**Bruna de Queiroz (NIOZ, COS)** Matthias Kuderer (UU, GEO) Ruoying Dai (UU) Arya Iwantoro (UU, GEO) Hung-An Tian (NIOZ, OCS)	**Claudia Wieners (UU, IMAU)** Julian Vosseberg (UU, Bio-Info) Charlotte Eich (NIOZ, MMB) Siham de Goeyse (UU/NIOZ, OCS) Rick Hennekam (NIOZ, OCS) Susanne van Donk (NIOZ, COS)	**Dina Castillo Boukchtaber (NIOZ, MMB)** Chiu Cheng (NIOZ, EDS) Indah Ardiningsih (NIOZ, OCS) Haorui Peng (UU, GEO) Muriel Bruckner (UU, GEO) Nadine Smit (NIOZ, MMB)	**Gonçalo Piedade (NIOZ, MMB)** Bram van Dijk (UU, Bio-Info) Milou Arts (NIOZ, MMB) André Jüling (UU, IMAU) Sanja Selakovic (UU, GEO)

Optical and acoustic sensors for detection and quantification of biotic and abiotic particulate matter in terrestrial and marine environments.	Uncertainty in marine paleoclimate proxies	Food web quantification and modelling	Where do ecosystem services originate?	Humans and nature	Filling the tree of life with molecular methods
Sabine Haalboom (NIOZ, OCS) Jaco de Smit (NIOZ, EDS) Thomas Hoyle (UU) Jingjing Guo (UU, GEO) Marieke Laengner (NIOZ, EDS)	**Peter Nooteboom (UU, IMAU)** Kalijn Peters (UU, GEO) Ruth Perez Gallego (UU/NIOZ, MMB) Linda Dämmer (NIOZ, OCS) Kristin Ungerhofer (NIOZ, OCS)	**A de Kluijver (UU, GEO)** Greg Fivash (EDS) Ulrike Hanz (UU/NIOZ, OCS) David Wichmann (UU, IMAU) Karlijn Doorenspleet (NIOZ, MMB)	**Christiaan Hummel (NIOZ, EDS)** Julia Karagicheva (NIOZ, COS) Danghan Xie (UU, GEO) Roeland van de Vijsel (NIOZ, EDS) Camilla Bertollini (NIOZ, EDS)	**Jildou Schotanus (NIOZ, EDS)** **Celine van Bijsterveldt (NIOZ, EDS)** Divyae Prasad (UU, Bio-Info) Ilja Kocken (UU, GEO) Tim Sweere (NIOZ, OCS) Saara Suominen (NIOZ, OCS) Christine Boschman (NIOZ, MMB)	**Bastiaan von Meijenfeldt (UU, Bio-Info)** Ella Wesdorp (NIOZ, MMB) Alena di Primio (NIOZ, MMB) Mathijs van Manen (NIOZ, OCS) Eva Deutekom (UU, Bio-Info)

How to integrate biological/ecological models with oceanographic hydrodynamical models?
Evert de Froe (NIOZ, EDS/OCS) Anna van der Kaaden (NIOZ, EDS) Philippe Delandmeter (UU, IMAU) Alice Stuart-Lee (NIOZ, EDS) Pieter Dirksen (UU, GEO)

Descriptions (as received from the workshop leaders) - Morning session

How to approach interaction at spatial and temporal microscales?	Strategies for more ecological sand mining	How to use Lagrangian modelling to analyse ocean and coastal dynamics?	Eukaryotic algae for fuel or sea surface temperature proxies.	Evolution: patterns and predictions	Viruses; small biological entities that can have large ecological effects
Saara Suominen (NIOZ, OCS) With environmental measurements we aim to describe the ecosystem around us, but we are often overlooking microscale worlds that the organisms that we study inhabit. In this session we will discuss the challenges of measuring and describing interactions at temporal and spatial microscales. What strategies can we use to detect and approach these interactions, and what kind of innovations are happening in the field today. Understanding the right scale for our study subject is important for the accurate description of ecological mechanisms driving ecosystems and biogeochemical cycles.	**Chiu Cheng (NIOZ, EDS)** Sand mining, which is the extraction of sediment from the seabed, in the nearshore environment is especially important for coastal countries such as the Netherlands. The material dredged is commonly used for a multitude of purposes including beach nourishment, construction of coastal protection infrastructures, manufacturing of materials such as concrete, among other beneficial purposes for society. However, the removal of sand directly impacts the ecosystem and caution must therefore be undertaken to avoid unintended consequences such as the permanent loss of entire communities of benthos, exacerbation of erosion or deterioration in water quality. Unfortunately, the requirements for sand mining are only expected to further increase in the foreseeable future, necessitated in part by increasing threats from sea level rise, etc. What can we do to develop and implement better strategies, and/or improve existing ones, that would satisfy both our socioeconomic needs, as well as minimizing the ecological impacts?	**Philippe Delandmeter (UU, IMAU)** A key aspect of marine science consists in analyzing huge data sets. While the data can come from observations, modelling results, a combination of both or another source, the goal is always the same: to digest this amount of data in order to understand the main processes of interest. A popular tool of processing this data is Lagrangian modelling: we release particles in the domain and analyse their dynamics. The advantage of this tool is that we can setup easily any kind of variables attached to each particle: age, community id, status, … Particle dynamics can also be freely defined. It does not have to simply follow the flow field, such that we can use Lagrangian modelling for a large variety of applications, from water masses to larvae, and from plastic to fish. But Lagrangian modelling provides itself a new set of data which in turn needs to be analysed. During this workshop, we will discuss how could we process those particle data. For some applications, the answer to this question is straightforward, but finding the best quantitative numbers or fields summarising a complex flow field can be a challenge. The goal here is to address this challenge using different perspectives from each participant's experience !	**Ruth Perez Gallego (UU/NIOZ, MMB)** Changes in global temperatures through Earth's history are tracked using different lipids known as biomarkers. Recently the increase in global temperatures is becoming a reality and one of the main requirements to keep it at bay is to cut on carbon emissions. A way to achieve this is by reducing our dependency from fossil fuels and turning to renewable sources of fuel such as bioethanol from corn or cyanobacteria and lipids from microalgae. What are the advantages of using microalgae as an alternative fuel source? Could this microalgae lipids used as biomarkers be also used as a fuel source?	**Bram van Dijk (UU, Theo-Bio)** After 150 years of studying the topic, evolution still has the ability to surprise us. When studying microbial evolution through experimental evolution, (meta)genomics, or theoretical models, the ability of evolution to be creative and come up with unexpected solutions seems unlimited. Furthermore, short term benefits are often at odds with long term fitness effects, which makes extrapolating from limited data inherently risky. Can we see generic patterns in the sea of non-generic adaptations? Can we predict what solutions evolution will tend to use, or are there truly "endless forms most beautiful"?	**Ella Wesdorp (NIOZ, MMB)** Viruses are biological entities, composed of genetic material (DNA/RNA) and a protein coat (sometimes also lipid envelope). Viruses have ecological effects by acting as a mortality agent and affect biodiversity through selective infection, co-evolution and succession. As parasites viruses both kill and need their host.

Exploiting the deep: How will anthropogenic exploitation of submarine canyons impact these deep sea habitats?	Glacier-ocean interactions in the Arctic	From field to computer, what field data do modelers need and how do we obtain it?	Predicting future sea level rise by comparing present day conditions with past analogues	Fe in the Ocean: Effect of ligand composition on microbial iron acquisition	Fe in the Ocean: Source, transport and cycling
Sofia Ledin (NIOZ, OCS) Submarine canyons are regarded as major conduits for organic matter transport, together with its heterogeneous topography allows for high biomass and species diversity. Anthropogenic affects such as fishing, resulting in seafloor erosion and litter, including litter and waste production from the shelf transportedthrough the system will have a significant impact. How do we research and measure this affect in these deep sea ecosystems?	**Alice Stuart-Lee (NIOZ, EDS)** We'll be considering glacier-ocean interactions in the Arctic with respect to the workshop theme. Greenland's glacial fjords are the connection between the vast Greenland Ice Sheet and the global ocean, supporting complex marine ecosystems and processes that transform the properties of the water during its transport. We can look to the physical, biological and chemical consequences of glacial melt for these fjord systems, and link together the expertise of each of the participants to the broad research area.	**Jaco de Smit (NIOZ, EDS)** Coupled morphodynamical and ecological modelling is still in it's infancy, but essential in unravelling future changes in coastal systems. One of the challenges is to come up with ways to translate the relevant biota-physical environment interactions into parameters that can be used for modelling. For this, experimental ecologists will need to collect field data in such a way that it can easily be translated into modellers language while modellers will need to understand the methods and limitations of field research. Therefore, collaboration between these disciplines is needed.	**Frida Hoem (UU, GEO)** Future sea level rise is one of the largest concerns for the population, but still hold large uncertainties. Understanding feedbacks and sensitivity between climate, ice sheets, and oceans under climate oscillations are critical. How can we best utilise proxy data to get accurate projection of future sea level change?	**Mathijs van Manen (NIOZ, OCS)** Nearly all dissolved iron in the ocean is complexed by strong organic ligands of mostly unknown composition. The effect of ligand composition on microbial iron acquisition is poorly understood. Siderophores are organic compounds that are synthesized by microbes to facilitate iron uptake and are believed to be a dynamic ligand pool. With a tandem HPLC-ICPMS and HPLC-ESIMS we try to characterize and quantify this siderophores.	**Hung-An Tian (NIOZ, OCS)** Fe is an especially crucial element for autotrophic plankton which contribute significantly to the food web of marine environments. To better understand the source, transport and cycling of Fe, Fe isotopic signatures provide an unique feature which enables us to not only identify but also quantify the external sources of Fe to the oceans. However, this approaches could be more comprehensive by collaborating together with modeler, chemists and biologists.

Ecosystem self organization	Endophytic microbiomes of Azolla sp. ferns
Roeland van de Vijsel (NIOZ, EDS) We suggest that self-organisation has been an important ecosystem engineering strategy throughout Earth's geological lifespan. We support this idea with studies on present-day patterned estuarine landscapes formed by primitive biofilms. The persistence of these patterns gives rise to laminated deposits strikingly similar to stromatolites, one of the earliest ecosystems on our planet. Ancient stromatolites, found abundantly in fossil records, might thus have been self-organising as well. Using fossil records, can we predict the development of modern self-organised ecosystems under future climate change?	**Laura Dijkhuizen (UU, Bio)** I study endophytic microbiomes and ecology of the floating fern Azolla: the fern that acquires all nitrogen it needs through a heritable symbiosis with endophytic cyanobacteria. Microbial communities reside inside specialized cavities in the Azolla leaves. The microbiome is systematically inherited by next generations. Until recently, only one member was known, now we know more species are found systematically in multiple Azolla species. One of my research lines focusses on the identity and functionality of microbes shared by multiple Azolla species. I also study the microbial relations outside Azolla. How to find and test functions of microbes I cannot culture in a plant I cannot transform? How does it influence the water it floats on and how does it acquire phosphorus from water and/or sediments?

Descriptions (as received from the workshop leaders) - Afternoon session

Marine plastic data	Predicting the future state of the AMOC using observations of past and present AMOC variability	Large-scale and long-term simulations – How to use complex process-based models and yet obtain realistic results?	Geoengineering - a cool plan or megalomania?	Building interdisciplinary teams: A way of making better projects	Energized! Top-down bottom-up. Who drives the system the energy source or the consumer?
Mikael Kaandorp (UU, IMAU) If we want to model the movement of plastic litter in our oceans, we need data to calibrate/validate our models. Although there are data available on plastic litter from e.g. trawls and beach clean-ups, these data are quite inconsistent and therefore difficult to use. In particular for beaches it is difficult to obtain high quality data. Would it be possible to come up with some sort of field-work plan which can be applied worldwide by many different people, guaranteeing scientific consistency/usefulness, while at the same time being fun/engaging enough to get a lot of people (not necessarily from science) involved?	**Roos Bol (NIOZ, OCS)** The Atlantic Meridional Overturning Circulation (AMOC) is a key component in the Earth's climate system. Its northward heat transport has an important effect on the climate of Northwest Europe. Changes in the AMOC are expected to occur as a consequence of climate change, but there is no consensus on what exactly these changes will entail. Recently, several studies have been published suggesting that the AMOC is in fact declining, but the evidence is elusive and the scientific community remains divided. This session will focus on different research methods used to observe and predict AMOC variability, from paleoclimatology to moored observations to modelling studies, and on how these research efforts can interact to improve AMOC predictions.	**Bruna de Queiroz (NIOZ, COS)** Morphodynamic simulations usually require high computational time. For instance, in a small domain such as a beach in the Netherlands (e.g. Noordwijk) with around 150 wave conditions, a complex process-based model such as Delft3D would take around 1 week to simulate 1 year, assuming 1 hour run-time per wave condition. The run-time is relative to the temporal and spatial scale, so if we increase the simulation time for 100 years and the spatial scale to the size of the North Sea, the computational time becomes unfeasible. There are methods to reduce the computational time of complex process-based models such as input reduction. However, higher the time/spatial scale, higher the errors associated to input reduction. This workshop proposes a discussion on the challenges of long-term and large-scale simulations using complex process-based models and how to tackle them.	**Claudia Wieners (UU, IMAU)** With CO2 emissions ever rising despite the Paris agreement, alternative solutions are searched to fix the climate problem: Geoengineering - large-scale human intervention with the earth system to control the climate. Several schemes have been suggested, including ocean fertilisation with iron, marine cloud brightening, afforestation of the Sahara, and creating a veil of reflective stratospheric aerosols, as observed after explosive volcanic eruptions. Can these seemingly harebrained schemes be effective? Can we be sure that the cure is not worse than the disease? In this workshop, we will discuss scientific uncertainties around geoengineering, and what we as climate scientists should do to solve them - before policy makers become so desperate that they blindly implement geoengineering!	**Dina Castillo Boukchtaber (NIOZ, MMB)** On the road that we undergo in our scientific careers - specialization is inevitable. And as our knowledge, interests, and subsequently visions, deepen and grow narrow, the bigger picture is sometimes lost along the way. So when the time comes to be creative and plan our own projects we may need a critical eye to avoid repetition and predictability in our research. This can easily be resolved when we expose ourselves to the dialogue with people from different, sometimes opposite fields and disciplines, often coming from different research institutes, universities, i.e. And even though scientific collaboration is something that always looks good on paper, we are rarely taught effective ways to achieve it on a level besides the informal integration with our closest peers. In this brief workshop we will explore the benefits and also the limitations of collaborations among peers, and aim to build a brief but concrete collaboration proposal. The participants that attend the workshop, should bring any ideas from their current projects or other research interests, but most importantly come with an open mind!	**Gonçalo Piedade (NIOZ, MMB)** An ecosystem can be described as an energy diagram. At the base, we have the producers that use light or redox gradients as their energy source and upper in the chain of energy we have the consumers who at the same time are an energy source again to others higher up in the chain. Ecosystems are complex and the species composition, behaviour and evolution is regulated by bottom-up (resource/prey availability) and top-down (predation, grazing, viral lysis) control. In this informal workshop, we will look into our fields of study while keeping in mind energy as currency coin and come up with interesting questions that interconnect the fields of study of the participants.

Optical and acoustic sensors for detection and quantification of biotic and abiotic particulate matter in terrestrial and marine environments.	**Uncertainty in marine paleoclimate proxies**	**Food web quantification and modelling**	**Where do ecosystem services originate?**	**Humans and nature: To what extent should locals be held responsible for ecosystem degradation if governments have other priorities?**	**Humans and nature: Building with nature. How can we use nature in our advantage?**
Sabine Haalboom (NIOZ, OCS) Optical and acoustic sensors are widely used for detection and quantification of biotic and abiotic particulate matter in marine waters. These field-deployable sensors are used in scientific, engineering and environmental-monitoring applications, contributing to our understanding of for instance sediment transport processes. This includes measurements of turbidity, which are needed to quantify sediment fluxes at continental margins, in submarine canyons, contaminant transport and anthropogenic disturbances, e.g. deep-sea mining. It is known that the sensor response is affected by different parameters including particle size distribution, shape and surface roughness and composition and colour of the material, making quantitative analysis of natural particle suspensions often cumbersome. By comparing simultaneously obtained records of optical and acoustic backscatter obtained by different types of commonly used sensors to quantitative results on concentrations and particle size distributions of suspended particulate matter in water samples we try to understand the effect of physical properties on the different types of measurements, as this is vital to quantify the amount and type of material that is transported.	**Peter Nooteboom (UU, IMAU)** This workshop focuses on how models could improve marine proxies. More specifically, we will focus on planktonic foraminifera, dinoflagellate cysts and coccoliths. These proxies are found in sediments at the bottom of the ocean and represent conditions at the ocean surface. Uncertainties could arise in the sinking of these particles from the surface to the bottom of the ocean.	**A de Kluijver (UU, GEO)** Food web and ecosystem models are powerful tools to integrate and upscale field and laboratory data to an ecosystem level. Which techniques do we use to quantify food web interactions (e.g. stable isotopes)? What models do we use (e.g. linear inverse models)? How do we deal with complexity? How do we define an ecosystem (in space)? These questions will be discussed in this workshop.	**Christiaan Hummel (NIOZ, EDS)** The Ecosystem Services (ES) framework is a highly anthropocentric way of looking at nature. The challenge in using an ES framework for nature management (or even Protected area management), lies in the fact that the ES framework usually focusses only on the outcomes of a system (nature) making overexploitation eminent. The ES framework can however also be used to incorporate stakeholders in decision processes, or show the public at large what nature means to humans, and what we should protect from overexploitation. The difference in view is caused by the different ways we can look at ES, from an anthropocentric point of view (demand), or from a natural point of view (supply). To be able to successfully use an Ecosystem Service framework without the danger of overexploitation we need to ask ourselves the question: Where do ecosystem services originate, in nature, or in society?	**Celine van Bijsterveldt (NIOZ, EDS)** As scientists we often work on exciting and cutting edge innovations and research topics, which is often co-funded by companies. This type of research is becoming more and more common as finding societal relevance for research topics and proving the relevance of a research topic by having one or more societal partners such as companies and NGOs is often a requirement at fund applications. This is cool because it means that we can see our efforts directly applied in “real life” but it also means that we as scientists are more under influence of our co-funders as well. The outcome of your research may for instance proof that a certain technique does not work, or is even dangerous for the environment. Or perhaps an NGO is interested in the hypothesized negative effect of removing part of an ecosystem, and you find out that this should not actually not be such a problem? How do we deal with such outcomes? And to what extend are we independent ourselves and are we not biased by our own or others beliefs?	**Jildou Schotanus (NIOZ, EDS)** More than a third of the global human population lives in coastal areas. An extended infrastructure consisting of hard structures such as dikes, groynes and sluices make this possible. However, these kind of structures can be a burden on the environment and are often not sustainable in the face of climate change. Building with nature is a concept that uses natural systems and the ecosystem services they provide to meet society needs and at the same time protect and restore ecosystems. There are already a few projects that uses this concept to protect coastlines from erosion but can we think of innovative ideas that uses the building with nature concept to meet our increasing needs?

Filling the tree of life with molecular methods	**How to integrate biological/ecological models with oceanographic hydrodynamical models?**
Bastiaan von Meijenfeldt (UU, Bio-Info) In recent years, molecular methods have greatly expanded our knowledge of the tree of life, with no signs of finalization in near sight. With a large part of unknown biodiversity residing in the world's ocean, opportunities to find novel biology in it are abound. Let's find the next brake-trough earth-shattering never-expexted-to-be-living organisms together!	**Evert de Froe (NIOZ, EDS/OCS)** To investigate the interplay between ecology and hydrodynamics it would be beneficial to model both dynamics together. 3D hydrodynamic models can give insight into complex processes, but they are time consuming to build and take a lot of computer power. They also work on different time- and/or spatial-scales as most ecological models. How can we integrate hydrodynamics and ecology to simulate their dynamics, or should we maybe not use dynamic models? (Intro written by Anna)