NESSC

Days

2021

November 4-5
Hotel Zuiderduin
Egmond aan Zee

Welcome to NESSC Day 2021!

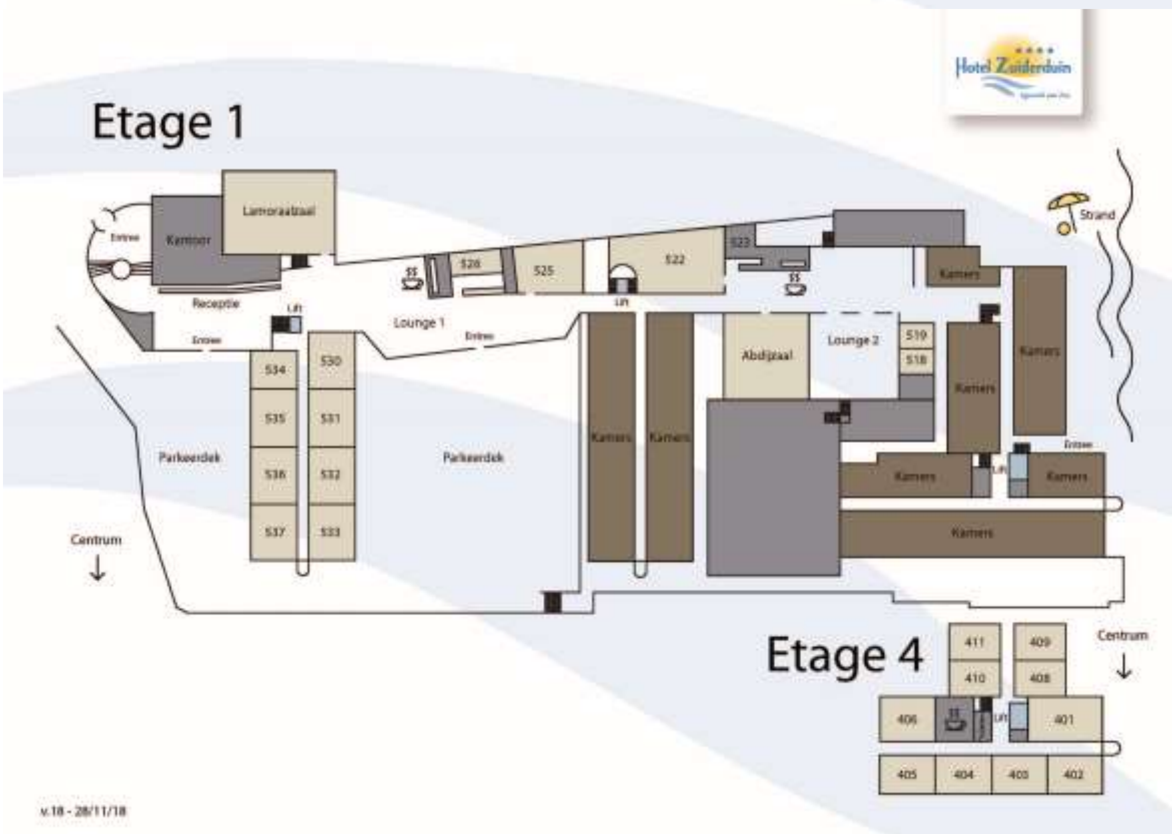
INTRODUCTION

It’s been a long time since we’ve all met face-to-face. In fact, for many of us, this is the first time we’ve ever met our non-institutional colleagues! We have multiple guest speakers and some activities in store, including an interactive panel discussion on climate science and policy- so don't forget to submit your questions before November 4. It’s a busy programme, but not to worry, as we have also included some social activities for us to all get to know each other better!

COVID RULES

As this event is not a 1.5-metre distancing event, you need to prove your vaccination status or present proof of a negative test.. Upon your entry to the hotel, you must supply a QR code through the CoronaCheck app, in conjunction with photo ID. If you do not have the CoronaCheck app, you must produce a COVID vaccination certificate, or proof of a negative COVID test within the past 24 hours (also in conjunction with ID). You will then be given a wristband for each day of your attendance.


Etage 0
Hotel Zuiderduin
Strand
Entree
Kantoor
Zaal 558
Zaal 559
Toiletten
Squash
Wally de Walrus
Fietsverhuur Bike Mike
Lucky Strike Bowling
Brasserie Bijou
Zenmoodz Beauty - massage
Sauna's en zwembad
O'Donnell's Pub
Kamers
Foyer
Van Speykzaal
Centrum
Parkeergarage
Ritz
Zuiderduinzaal
Restaurant
Toiletten
Centrum
v.18 - 28/11/18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v.18 - 28/11/18

PROGRAMME OVERVIEW

PROGRAMME

All events take place in The Abdijzaal

Thursday November 4th

11:00-14:00	*PhD students and postdocs communication workshop- including lunch*
13:30-14:00	Coffee and registration
14:00-14:15	Welcome by Scientific Director & NESSC office
14:15-15:15	Keynote lecture Dr Clara Bolton, Cerege Aix en Provence *The Secret life of Plankton – Reconstructing the surface ocean through a biological lens*
15:15-16:40	Introduction and presentations Theme 1 *Introduction by theme leaders Caroline Slomp & Mike Jetten* • *Jeremy Emmet - A Microbial-Focused Model of Methane Emission from Siberian Permafrost* • *Koen Pelsma - Redox biogeochemistry and anaerobic methane oxidation across in urban canals along a salinity gradient* • *Malavika Sivan - Isotopic characterisation of methane using clumped isotopes* • *Wytze Lenstra - Precession-driven changes in riverine phosphorus input control carbon and oxygen dynamics in the Neoarchean – early Paleoproterozoic*
16:40-16:55	Introduction and presentations Theme 2 *Introduction by theme leaders Francien Peterse & Jorien Vonk* • *Bingjie Yang – short introduction on her PD project* • *Tipping Point Ahead film, starring Anne Kruijt*
17:00-18:50	Posters and social drinks *Theme 1 and 2 will have time to present their posters from 17:00-17:50* *Theme 3, 4, and 5 will have time to present their posters from 17:50-18:50*
19.00-21.00	Dinner

Friday November 5th

9:00-10:05	Introduction and presentations Theme 3 *Introduction by theme leaders Jack Middelburg & Gert-Jan Reichart* • *Yanming Ruan High temperature gas chromatography coupled to isotope ratio mass spectrometry: a technical endeavor to better constrain the global carbon cycle* • *Szabina Karancz - Quantifying the carbon pump's efficiency in the Benguela Upwelling System during the last 25 ka* • *Laura Pacho Sampedro - Multi element (Mg, Sr, Na and K) to calcium ratio calibration of benthic foraminifera Amphistegina lesson using controlled growth experiments*
10:05-11:05	Keynote lecture Dr Aimee Slangen, NIOZ *The IPCC report and sea level change*
11:05-11:20	Coffee break
11:20-12:35	Panel discussion on climate science and climate policy *Hosted by Bjinse Dankert, with panelists:* • *Prof. Dr. Roderik van de Wal (Utrecht University, NESSC)* • *Dr. Christel van Eck (Universiteit van Amsterdam)* • *Dhr. Hugo van Bergen Liaison Officer Parliament and Science* • *André Jüling (NESSC Alumnus)*
12:35-13:30	Lunch break
13:30-14:45	Introduction and presentations Theme 4 *Introduction by theme leader Appy Sluijs:* • *Allix Baxter – Contrasting glacial and interglacial temperature-moisture relationships predict increased future water stress in East Africa* • *Meike Scherrenberg - Simulating the Last Glacial Cycle Ice Sheet Evolution* • *Katrin Haetig - Mid Miocene seawater isotope reconstructions: comparison between foraminifera based oxygen isotopes and alkenone based hydrogen isotopes* • *Dominique Jenny - Oligocene Equatorial Atlantic climate dynamics*

14:45-15:30	Introduction and presentations Theme 5 *Introduction by theme leaders Luc Lourens & Marten Scheffer* • *Shruti Setty - Causal Interactions in the Cenozoic Carbon-Climate System* • *Daan Boot - Effect of ocean circulation changes on air-sea gas exchange of CO2 in CESM2*
15:30-16:00	Prizes (Poster/Presentation)
16:00-17:00	Social activity (optional)

GUEST SPEAKERS

Dr Clara Bolton

(CNRS/CEREGE, France)

About the speaker:

Clara Bolton (she/her) is a CNRS researcher at CEREGE (France) since 2014. She graduated from the University of Southampton (UK) with a PhD in Paleoceanography in 2010, and subsequently worked as a post-doctoral researcher at the University of Oviedo (Spain). Her research focuses on (1) the adaptation of calcareous plankton to climate change on geological timescales and how this adaptation is transferred to the fossil record (proxy development), and (2) reconstructing paleoclimate and paleoproductivity on orbital to secular timescales in the Neogene, using a combination of micropaleontological and geochemical approaches.

Abstract:

The Secret life of Plankton – Reconstructing the surface ocean through a biological lens

Plankton are key players in the ocean carbon cycle and modulators of global climate. At the same time, they are sensitive recorders of physical and chemical changes in upper ocean conditions. A number of phytoplankton and zooplankton groups produce fossilizable parts that are preserved in the marine sedimentary record and can provide important clues about past ocean states, as well as their capacity for adaptation. In this talk, I will introduce plankton-based proxies in paleoceanography, then focus on specific examples utilizing the organic and inorganic fossil remains of coccolithophores, an abundant calcifying phytoplankton group. I will discuss recent advances in our ability to reconstruct ocean carbon dioxide concentrations using isotopic fractionation in coccolithophores, and the new application of fossil coccolith morphology to reconstruct past evolution within a key family of this phytoplankton group.

Dr. Aimée Slangen

Royal Netherlands Institute for Sea Research (NIOZ)

About the speaker:

Dr. Aimée Slangen is senior researcher at the Royal Netherlands Institute for Sea Research (NIOZ) in Yerseke. Her research focus is sea-level change, both in the open ocean and the interaction at the coast. With her research group, she aims to improve our understanding of sea-level change in the past, as well as making better projections for the future. She is Lead Author of the IPCC AR6 report, on Chapter 9: Oceans, Cryosphere and Sea Level Change.

More information: https://www.nioz.nl/en/about/organisation/staff/aimee-slangen

Abstract:

'The IPCC report and sea level change' by Aimée Slangen

In August, the IPCC sixth assessment report was published. The report is a comprehensive overview and assessment of the current state of climate science. During the lecture, we will first discuss the IPCC itself: what is IPCC, how does it work, and what is the procedure towards an IPCC report? Then, we will discuss the main findings of the report, with a focus on observed and projected changes in sea level. Which processes are driving sea-level change, and how will sea levels change in the future?

PANELLIST

About the panellist:

Hugo van Bergen is Parliament & Science liaison on behalf of The Young Academy, the Royals Netherlands Academy of Arts and Sciences (KNAW), the Dutch Research Council (NWO), the Association of Universities in the Netherlands (VSNU); the Netherlands Federation of University Medical Centres (NFU) and TNO. He used to work for – successively – the VVD-parliamentary party in the Dutch House of Representatives; the Ministry of Economic Affairs; Science Centre NEMO, Dutchtone/Orange Netherlands, consultancy firm Winkelman & Van Hessen and the KNAW. Since January 1st 2019 he is fully dedicated to Parliament & Science. See: https://parlementenwetenschap.nl

About the panellist:

Dr Christel van Eck works as an Assistant Professor at the Amsterdam School of Communication Research (UvA). Broadly, her research focuses on climate change communication and polarization. More specifically, she is interested in investigating the role of online media in climate change polarization. Christel is passionate about bridging the science and practice of climate change communication.

About the panellist:

André works as a postdoc at the sea level group of the Royal Dutch Meteorological Institute (KNMI) where he investigates the interaction between ice sheets and the ocean. He is a NESSC graduate, having done his PhD on variability and response in high-resolution Earth System Models at Institute for Marine and Atmospheric research Utrecht. In addition to his scientific work, he enjoys science communication, both to the general public and with environmental and non-governmental organisations. He believes the latter are crucial to opening the political space needed to advance environmental legislation.

About the panellist:

Roderik van de Wal is a climate scientist working on sea level changes and coastal impacts at Utrecht University (Department of Physical Geography and the Institute for Marine and atmospheric research Utrecht (IMAU) with a focus on modelling the past and future evolution of ice sheets. He has been involved in various roles in various IPCC reports and is co-chair of the WCRP Grand Challenge on Regional Sea Level.

See: www.staff.science.uu.nl/~wal00105/

PRESENTATIONS AND ABSTRACTS

Dr. Jeremy Emmett
Vrije Universiteit Amsterdam

A Microbial-Focused Model of Methane Emission from Siberian Permafrost

Permafrost covers nearly a quarter of the northern hemisphere land surface (1) and contains nearly twice the carbon store of the atmosphere (2). Warming of the arctic near-surface is expected to induce thaw-degradation of permafrost, accelerating microbial soil carbon decomposition and biogenic GHG production that may promote a positive warming feedback (3). CH_4 emission is of particular interest given its 100-year GWP of ~30 (4). Because of microbes' fundamental role in soil CH_4 production (5), coupling microbial dynamics with permafrost land-surface modelling is critical for elucidating and predicting the complex biogeochemical processes underlying this feedback.

Early development of a Python-based microbial model is underway to complement permafrost land-surface codes e.g., CryoGrid. Inspired by recent wetland and marine sediment-focused methodologies, this microbial component will incorporate population dynamics terms e.g., growth and mortality (6), Michaelis-Menten-derived reaction rates for hydrolytic and methanogenic and methanotrophic metabolic pathways (5), and metagenomics as a tractable proxy for the relative occurrence of pathways (7).

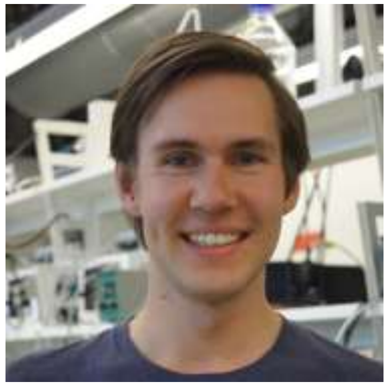
Initial focus will be on the northeastern Siberian region (Kytalyk monitoring site) where permafrost terrain exhibits relatively high near-surface carbon concentrations (2). Continuous acquisition of meteorological and flux-tower data, in conjunction with Summer 2022 fieldwork, will provide physical and microbiological parameters for model forcing, calibration, and validation: net surface CH_4 fluxes, soil temperature, moisture, and pH profiles, key chemical reactant and product concentrations, and metabolic-encoding gene concentrations.

Three avenues for investigation are anticipated: to explore the relevance of microbial dynamics in explaining seasonal and diurnal variations in CH_4 emission, investigating site-level spatial variations in emission arising from permafrost terrain in-homogeneity, and predicting response to 21st century climatic warming projections at local and arctic-spanning scales.

1 https://doi.org/10.3133/cp45
2 https://doi.org/10.5194/bg-11-6573-2014
3 https://doi.org/10.1007/978-3-030-31379-1
4 https://doi.org/10.1017/CBO9781107415324.018
5 https://doi.org/10.1029/2019MS001867
6 https://doi.org/10.1029/2020GB006678
7 www.pnas.org/cgi/doi/10.1073/pnas.1313713111

Koen Pelsma MSc

Radboud Universiteit



Redox biogeochemistry and anaerobic methane oxidation across in urban canals along a salinity gradient

Human activity has caused an explosion in the atmospheric concentration of greenhouse gases, most prominently of carbon dioxide (CO2) and methane (CH4). Currently, about 30% of yearly CH4 emissions are attributed to sources like lakes, rivers, and wetlands. There is increasing evidence that man-made aquatic systems, for example canals and ponds, release significant amounts of CH4. The geochemical and biological controls on CH4 are as of yet unknown, especially for urban canals. Here, we characterised three distinct sites in the city centre of Amsterdam to identify key processes that might affect the production or oxidation of CH4. Diffusive CH4 fluxes from the water to the atmosphere were 0.88-2.34 gCH4 m-2 yr-1 confirming that these canals are sources of atmospheric CH4. Biogeochemical characterisation of the sediment identified a sulfate-methane transition zone at 5-10 cm depth for the site that was marked by a high salinity. All sites were quickly depleted of nitrate within the first 3 centimetres of sediment, indicating that this is not a relevant electron acceptor for anaerobic CH4 oxidation (AOM). Incubations with sediment slurries to test for AOM under a range of electron acceptors confirmed this observation. Surprisingly, amending the sediment with graphene oxide seemed to enhance the consumption of CH4, leading to the hypothesis that humic substances may be a key electron acceptor for AOM in urban canals. 16S rRNA gene sequencing identified hydrogenotrophic methanogens as the dominant source of CH4 and this was confirmed by the isotopic signature of porewater CH4. At the site with the highest salinity ANME2a-2b were enriched in the sediment, suggesting their role as methane oxidisers in this ecosystem. We posit that AOM with humic substances may offset some of the CH4 coming out of urban canals in Amsterdam.

Malavika Sivan MSc

Utrecht University

Isotopic characterisation of methane using clumped isotopes

Methane is a strong greenhouse gas in the atmosphere with a high global warming potential. Considering its importance, various methods are being employed to identify and distinguish between the different sources that emit methane to the earth's atmosphere. The measurement of bulk isotopic composition (δ13C and δD) is the widely used characterization technique, but due to the overlap of source spaces, it is oftentimes difficult to totally distinguish between thermogenic, microbial, and other sources. With the emergence of the new field of clumped isotope thermometry and advancement of high-resolution spectroscopic techniques, it is now possible to measure the very rare clumped isotopes of methane: 13CDH3 and CD2H2. This novel method can be used as an additional parameter to constraint methane sources. The clumping anomaly is temperature-dependent and can thus give information on the formation temperature of methane. In this study, we have developed a technique to extract pure methane from air and water samples and to measure the clumped isotope signatures (Δ13CDH3 and ΔCD2H2) with high precision and reproducibility. We will present the current capabilities of this setup, and the results of the first sets of samples from different environments.

Authors: Malavika Sivan, Elena Popa, Thomas Röckmann, Carina van der Veen, Caroline Slomp

Dr. Wytze Lenstra

Utrecht University

Precession-driven changes in riverine phosphorus input control carbon and oxygen dynamics in the Neoarchean – early Paleoproterozoic

The ferruginous Archean ocean is thought to have been phosphorus (P) limited, favouring primary productivity through anoxic photoferrotrophy at the expense of oxygenic photosynthesis. Corresponding rates of oceanic primary production and atmospheric oxygen concentrations would then have been extremely low.

Regular alternations in iron (Fe), sulfur (S), and P enrichments reported in banded iron formations of the Brockman Iron Formation (~2.46 Ga) point to a more complex picture, however, suggesting cyclical changes in the supply of riverine P and primary productivity controlled by climatic precession (forcing) in the Archean ocean. Periods of high inputs of P would then have shifted the ocean from P- to Fe-limited conditions, leading to periods of increased organic carbon deposition and oxygenation of the water column (Lantink et al., under review).

Here, we first discuss how increased terrestrial P supply would change the main pathways of primary productivity in the water column in the ocean of the Neoarchean – early Paleoproterozoic. Using a reactive transport model for marine sediments we then describe the expected depth distributions of Fe, S, and P in the banded iron formations. We also show how orbitally-induced insolation-driven changes in organic matter deposition would have changed the main pathways of organic matter degradation in the sediment. Importantly, we find that the production of sedimentary methane would have outpaced its oxidation. As a consequence, marine sediments may have acted as a source of methane to the overlying waters.

Lantink, M. L., et al., Precession as the pacemaker of early Earth's oxygenation, under review.

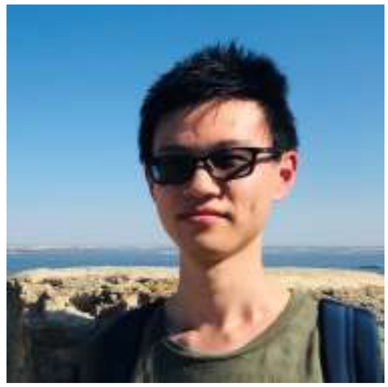
Wytze K. Lenstra1, Margriet L. Lantink1, Rick Hennekam2, Gert-Jan Reichart1,2 , Paul R.D. Mason1, Frederik J. Hilgen1 and Caroline P. Slomp1

1 Department of Earth Sciences - Geochemistry, Utrecht University, Utrecht, The Netherlands

2 Department of Ocean Systems, NIOZ, Netherlands Institute for Sea Research and Utrecht University, Texel, The Netherlands

Dr. Yanming Ruan

Royal Netherlands Institute for Sea Research (NIOZ)



High temperature gas chromatography coupled to isotope ratio mass spectrometry: a technical endeavor to better constrain the global carbon cycle

The geological past offers a rich archive of examples of the Earth system functioning in warmer states with higher atmospheric CO2 concentrations than today, providing valuable implications for the future. Accurately constraining the CO2 concentrations during these high-temperature-high-CO2 periods is crucial for understanding the Earth system as well as for future projections.

Crenarchaeol is a membrane lipid of Thaumarchaeota, a group of chemo-autotrophic marine planktonic archaea. Since they fix inorganic carbon, their stable carbon isotope composition including that of crenarchaeol reflects the isotopic composition of the seawater dissolved inorganic carbon in the past. The size of crenarchaeol, however, prohibits the measurement of its isotopic composition based on commonly used gas chromatography-isotope ratio mass spectrometry (GC-irMS). High temperature GC techniques provide a possible way to overcome this hurdle. Preliminary tests on pure culture and environmental samples show promising results when the target compound constitutes the major part of the total lipids in the sample.

Authors: Yanming Ruan, Marcel van der Meer, Stefan Schouten

NIOZ Royal Netherlands Institute for Sea Research, Department of Microbiology and Biogeochemistry, and Utrecht University, P.O. Box 59, 1790 AB Den Burg, Texel, The Netherlands

Szabina Karancz MSc

Royal Netherlands Institute for Sea Research (NIOZ)

Quantifying the carbon pump's efficiency in the Benguela Upwelling System during the last 25 ka

Upwelling regions are systems characterized by relatively cold and CO2-rich waters returning from depth to the sea surface. The high dissolved inorganic carbon (DIC) content of these upwelled waters results in an initial decrease in surface pH while the concurrent nutrient supply determines the efficiency of the biological carbon pump in returning CO2 in the form of downward organic carbon transport. This implies that the upwelling rate and nutrient utilization together determine CO2 outgassing. The Benguela Upwelling System offshore Namibia is a major upwelling region, where one of the most productive marine ecosystems exists today. However, studies on upwelling intensity during the last glacial cycle show contrasting signals, indicating an incomplete understanding of regional changes. To accurately reconstruct these processes in the Namibia upwelling region, we apply tracers for the changes of the carbon cycle based on both organic (e.g. δ13C of alkenones) and inorganic (e.g. δ13C, δ11B in foraminifera shell) proxy signal carriers. The δ13C will be measured in both planktic and benthic foraminifera shells to determine vertical gradients of carbon isotopes as a measure of the efficiency of the biological carbon pump. Along with the carbon isotopes, CO2 proxies are used to separately reconstruct individual parameters of the carbonate system, such as pH, pCO2, and [CO32-]. This multi-proxy approach allows quantification of the complete inorganic carbon chemistry and the evaluation of the role of the carbon pump in CO2 outgassing in an upwelling area over the last deglacial when major changes in the carbon cycling occurred globally.

Laura Pacho Sampedro MSc

Royal Netherlands Institute for Sea Research (NIOZ)

Multi element (Mg, Sr, Na and K) to calcium ratio calibration of benthic foraminifera Amphistegina lesson using controlled growth experiments

The fossil shells of foraminifera are popular agents to reconstruct past climate changes. The incorporation of elements into these shells depends on various environmental conditions. The effect of these parameters (e.g. temperature, salinity, pH) vary on partitioning of elements in foraminifera and are often influenced by multiple parameters. Hence combining different elemental/Ca ratios in foraminifera can be used to reconstruct different parameters simultaneously and also to improve reconstructions. For the conservative elements, such as Mg2+, Sr2+, K+, Na+, B(OH)3/B(OH)4-, SO42-, all of them with a mean oceanic residence time higher than 9 Myr, their incorporation is primarily affected by the physico-chemical conditions. The aim of the experiments is to is to isolate parameters of the carbonate system, salinity and temperature. We incubated specimens of the benthic foraminifera Amphistegina lessonii under a range of temperatures (18-28°C). From newly formed chambers, Sr/Ca, Mg/Ca, B/Ca, Na/Ca, S/Ca and K/Ca were determined using sector field inductively coupled plasma mass spectrometry (SF-ICP-MS). First results suggest a positive correlation of Sr/Ca, Mg/Ca co-varies with temperature , and K/Ca shows an inverse correlation with temperature. This suggest these ratios are a potential proxy for temperature, while there is no effect of temperature on Na/Ca. In a second set of experiments, the impact of inorganic carbon parameters will be tested on incorporation of the same elements, forming the basis for a multi-element to multi-parameter approach.

Allix Baxter

Utrecht University

Contrasting glacial and interglacial temperature-moisture relationships predict increased future water stress in East Africa

Our understanding of Earth's climate dynamics during the Quaternary is hindered by a shortage of proxy records from continental low-latitude settings that are both long and detailed. Analysis of branched and isoprenoid glycerol dialkyl glycerol tetraethers (brGDGTs) in the continuous and depositionally uniform sediment record of Lake Chala produced the first paired temperature and hydroclimate reconstruction from equatorial East Africa spanning Marine Isotope Stages (MIS) 4 to 1. It shows that the Heinrich-1 period megadrought (~17,000-14,500 years ago) was both the driest and coolest episode in the last 75,000 years. Contrary to most low-latitude regions worldwide the Last Glacial Maximum (LGM) was fairly wet by comparison, continuing the wet conditions which prevailed through most of MIS3. This may have promoted greater speciation and be the cause for the observed higher biodiversity of the eastern African continent and Arc Mountains than the Congo rainforest. Temperature and moisture balance both respond strongly to orbital precession and obliquity. Positive correlation between continental moisture balance and mean surface temperature (MST) during glacial time implies that intermittent drought was caused by weakened monsoon rainfall. Overall the glacial-era monsoon remained strong, due to only modestly lower MST (~3 °C) at sea level compared to today. In the Holocene (MIS1), continental moisture balance is inversely related to temperature, indicating that enhanced evaporation at high interglacial temperatures partly counteracted increased monsoon rainfall. This may partly explain the observed discrepancy between rainfall and moisture-balance reconstructions of the East African Humid Period, and why the half-precessional monsoon dynamics manifested across the glacial-interglacial transition is less prominent during the full-glacial period. Finally, our results imply that under future conditions of anthropogenically increasing greenhouse-gas (GHG) concentrations and temperature, equatorial East Africa is likely to experience regional drying and diminished future water resources notwithstanding IPCC projections of increasing rainfall.

Meike Scherrenberg MSc

Utrecht University

Simulating the Last Glacial Cycle Ice Sheet Evolution

When simulating ice sheet – climate feedbacks on multi-millennial time-scales, a set-up that uses a two-way coupled Earth System Model would be ideal. However, simulations of at least one glacial cycle with such a method are currently barely computationally feasible.

Alternatively, ice sheet models can be forced with an interpolated climate derived from GCM end-members, allowing researchers to study two-way interactions between ice sheet and climate, with enough computational efficiency to enable multimillennial-scale simulations.

Two methods of interpolation are discussed here: First the glacial index method, which introduces a linear interpolation between PI and LGM based on prescribed forcing such as d18O. Secondly, we use a climate matrix method which includes the ice thickness and volume such that the feedbacks induced by them are implicitly resolved.

Here we present simulations of the Last Glacial Cycle forced with LGM and PI snapshots derived from nine PMIP3 GCM's. The snapshots are interpolated using either the climate matrix or glacial index method and our aim is to compare and to evaluate the differences in ice sheet evolution and LGM extent.

The nine PMIP3 runs show a large intermodel variability resulting in sea level contribution ranging from 161 meters of sea level fall to 13.5 meters of sea level rise between Pre-Industrial and the Last Glacial Maximum. The glacial index method simulations result in smaller ice sheets in North-America, most likely due to the interior becoming arid much quicker compared to the climate matrix method. In Eurasia, the glacial index method resulted in smaller ice sheets for most PMIP3 forcing and generally showed less ice forming in the Barents Sea. This work shows that the climate matrix is to be preferred above the glacial index model, but above all shows that only a part of the climate models yield realistic results for the LGM.

Katrin Hättig MSc

Royal Netherlands Institute for Sea Research (NIOZ)

Mid Miocene seawater isotope reconstructions: comparison between foraminifera based oxygen isotopes and alkenone based hydrogen isotopes

In the last decade both culture and environmental studies have shown that the hydrogen isotopic composition of long-chain alkenones (δ2HC37) depends on the hydrogen isotopic composition of sea water, which correlates with salinity, and salinity itself (Schouten et al., 2006; Weiss et al., 2019; Gould et al., 2019). Culture and core top calibration studies suggest different sensitivities to salinity changes while glacial/ interglacial alkenone hydrogen isotope shifts are large and suggest a high salinity sensitivity or a large shift in salinity, larger than expected for open ocean conditions. This suggests a missing link in our understanding of hydrogen isotope fractionation by algae in relationship to environmental parameters.

Here, we compare foraminifera based oxygen isotope and alkenone based hydrogen isotope reconstructions of seawater based on a sediment record from the Mid-Miocene (IODP Site U1318, eastern North Atlantic Ocean, Sangiorgi et al., 2021) with expected global ice volume and local salinity changes. Previously published biomarker and dinoflagellate cyst proxies indicate a warm and mostly stratified water during the Miocene Climate Optimum (MCO) which cooled about 3 degrees across the Miocene Climate Transition (MCT). Additionally, 11 transient cooling events were documented using organic biomarker based (TEX86 and UK'37) paleothermometers.

Remarkably, the benthic oxygen isotopes in U1318 as well as the global benthic δ18O stack reveals a strong correlation with the SST proxies which indicates that the oxygen isotopes are highly temperature controlled at this site. However, the alkenone, sea surface, hydrogen isotope record shows different isotope excursions pointing to decoupled isotope and salinity processes between surface and bottom waters at this site.

Dominique Jenny MSc

Utrecht University

Oligocene Equatorial Atlantic climate dynamics

The unipolar icehouse of the Oligocene provides an opportunity to study the Antarctic influence on paleoclimate sensitivity and polar amplification due to its range of atmospheric CO2 (≈ 200-1400ppm) and strong climate variability. This is relevant because our current projections of CO2 emissions bring us to similar atmospheric CO2 concentrations as those of the Oligocene. Currently we have very little information about climate sensitivity and polar amplification and their hemispheric symmetry in the unipolar icehouse of the Oligocene and climate conditions in the equatorial realm.

Here we present long-term paleo-sea surface temperature (SST) reconstructions from equatorial Atlantic Ocean Drilling Program Site 959, offshore Ghana, based on lipid biomarkers (TEX86). Additionally, we reconstructed variations in paleoceanographic conditions using dinoflagellate cyst assemblages, bulk stable isotopes ratios (δ18O, δ13C) and magnetic susceptibility.

The generated data show that the prevailing SST during the Oligocene was surprisingly close to today's (≈ 27℃) and thus up to 4℃ colder than what we see at other Oligocene equatorial sites such as ODP Hole 929A, Ceara Rise. The dinoflagellate cyst assemblages contain species indicative of upwelling-driven nutrient abundance, alternating with those suggesting strong stratification. The combined results imply seasonal monsoonal upwelling and stratified waters in the inter-monsoonal time, which could explain the detected temperature discrepancy. Subsequent comparison of our equatorial SST record with general circulation modelling studies and SST records from high latitudes should reveal the polar amplification of warming and climate sensitivity on long and short (orbital) timescales during the Oligocene.

Shruti Setty MSc

Wageningen University & Research

Causal Interactions in the Cenozoic Carbon-Climate System

The last 66 million years of the Earth's history was interspersed with several abrupt and extreme events occurring concurrently in both the carbon cycle and the climate system, making this era the perfect specimen to unravel the association between these two systems. The more central question pertaining to these transitions is whether they are externally forced (eg. by volcanic degassing) or by internal climate-carbon cycle feedbacks. In addition, these events are shown to be paced by the eccentricity metronome of the Earth's orbit around the Sun. Considering that the eccentricity is only a minimal initial driver, this suggests a dominant role for amplifying internal mechanisms.

To better comprehend the mechanisms behind these transitions, we studied the causal- relationship between the climate and the carbon cycle in the CENOGRID, a 66 million year-reconstruction of these two systems. We employed a novel moving-window Convergent Cross Mapping (CCM) approach, which is a non-linear state space reconstruction-based tool for unravelling mechanistic-interaction between different variables of a dynamical system. CCM tests for causality between the paleo-reconstruction of the climate and the carbon cycle by measuring the extent to which the reconstructed state space from one system can reliably estimate the states of another system.

Our preliminary windowed-CCM analysis between the carbon cycle and the climate system during the Cenozoic era unveil an increasing causal mechanism between the two systems prior to the hypothesized abrupt transitions, followed by a reduction in the mechanism after the transition. Furthermore, we observe a consistently high causal interaction between the two systems during the Hothouse Earth (56 to 47 Ma), which is unseen elsewhere during this era. Our results could potentially be extracted to better comprehend the carbon emission-temperature coupling, which is touted to be responsible for the ongoing global warming.

Daan Boot MSc

Utrecht University

Effect of ocean circulation changes on air-sea gas exchange of CO2 in CESM2

Authors: Daan Boot, Anna von der Heydt, and Henk Dijkstra

Oceans have taken up approximately 30% of anthropogenic CO2 emissions over the Anthropocene. Ocean circulation plays a crucial role in the air-sea gas exchange of CO2 and thus the uptake of anthropogenic carbon. An important circulation component in the ocean is the Atlantic Meridional Overturning Circulation (AMOC). The AMOC receives a lot of attention because it modulates the climate of the North Atlantic by transporting heat from the Southern to the Northern Hemisphere. The AMOC has also been identified as a tipping element with two stable states. Tipping of the AMOC is expected to change the global climate and increase the risk of a 'tipping cascade'. In future projections, the AMOC strength is expected to decrease significantly and the risk of tipping increases. In this presentation we focus on the effect of a change in AMOC strength on the air-sea gas exchange of CO2. Our main question here is: does an AMOC weakening result in a positive feedback and an amplification of climate change, or does it result in a negative feedback and a damping of climate change?

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