PAGES 2025
7th OPEN SCIENCE MEETING
5th YOUNG SCIENTISTS MEETING

Earth System Changes from the Past towards the Future

PAGES 2025 ABSTRACT BOOK

5th YOUNG SCIENTISTS MEETING

19-20 May 2025 | Shanghai, China

CHINESE ACADEMY OF SCIENCES

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Welcome Message

Dear participants,

We are delighted to welcome you to the 5th PAGES Young Scientists Meeting (YSM), held at the prestigious and innovative Tongji University in China. Since its inception, PAGES has been committed to fostering interdisciplinary research on past global changes to enhance our understanding of Earth's climate and environment. As a Global Research Network of Future Earth and a scientific partner of the World Climate Research Programme (WCRP), PAGES continues to support early-career researchers in making meaningful contributions to this field.

The YSM was established to provide a platform for early-career researchers to exchange ideas, present their work, and engage in discussions with peers and senior scientists. Following the successful meetings in Corvallis (USA, 2009), Goa (India, 2013), Morillo de Tou (Spain, 2017), and a virtual edition in 2021, we are excited to bring the fifth edition of this inspiring event to Shanghai, a city that seamlessly blends tradition and modernity, provides an exciting backdrop for this meeting. We encourage you to explore its rich cultural heritage, diverse cuisine, and innovative atmosphere during your stay.

We look forward to a productive and inspiring meeting and hope that the connections you forge here will lead to lasting collaborations and future scientific endeavors.

PAGES YSM Scientific Committee

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1 Scientific Committee

Members
(in alphabetical order of the surnames)

Haowen Dang	Tongji University, Shanghai, China
Eugenia Ferrero	CCT-CONICET-MENDOZA, Mendoza, Argentina
Marie-France Loutre	PAGES International Project Office (IPO), Bern, Switzerland
Keely Mills	British Geological Survey, Nottingham, UK
Juliana Nogueira	Czech University of Life Sciences Prague, Prague, Czechia
Christine Omuombo	Technical University of Kenya, Nairobi, Kenya
Tsilavo Razafimanantsoa	University of Cape Town, Cape Town, South Africa
Shiling Yang	Institute of Geology and Geophysics Chinese Academy of Sciences, Beijing, China

2 General Information

Introduction

The 5th PAGES Young Scientists Meeting (YSM) hosted in Shanghai, China, in 2025, presents a unique opportunity for early-career researchers from around the world to showcase their ongoing research, interact with experienced scientists, and expand their professional network.

Through panel discussions, poster sessions and networking opportunities, the 5th PAGES YSM aims to inspire and empower the next generation of scientists, encouraging all participants to actively engage, share their perspectives, and build lasting connections that will shape the future of paleoscience. The YSM constitutes a start to the Open Science Meeting (OSM) for the participants.

Organizers and Sponsors

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3 Conference Program

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- Breakout groups: Based on 10 different topics, the discussions will be divided into 8 groups. Each group will include about 10 participants (see appendices). Participants will move to one of the 4 discussion rooms, i.e. C201, C301, C401, Poster Hall. Two groups will enter one room for discussion.

4. Invited Talk

Monday, 19 May

11:30-12:00

Delving into North Africa's past: Speleothem-paleoclimate research (and the role of PAGES)

Yassine Ait-Brahim[1*]

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North Africa is an interesting region for paleoclimate research due to its sensitivity to climate change, rich natural archives like speleothems, and its influence on human civilization. The region offers insights into global climate dynamics, Sahara desertification, and past marine conditions, making it a crucial area for understanding Earth's climate history and addressing current climate challenges. I will review the paleoclimate studies that have been carried out in North Africa, with a focus on speleothem records, on multiple timescales and discuss how PAGES (through its network, working groups, and financial support) helped to achieve some of our key results.

Short Bio: Yassine Ait-Brahim obtained his PhD in 2016 from University Ibn Zohr (Morocco) in collaboration with IRD (France) and the University of Sao Paulo (Brazil). He joined the International Water Research Institute (IWRI) of University Mohammed VI Polytechnic (UM6P) in November 2021, after five years of international postdoctoral research experience in China, Switzerland, and Canada. Yassine specializes in isotope geochemistry, hydrogeology, and paleoclimate, with a focus on speleothem records from North Africa. He has been heavily involved in PAGES' SISAL (Speleothem Isotope Synthesis and Analysis) working group.

5. Abstracts

【A0468】

Paleoenvironmental reconstruction of Laguna Ñe Luan, Patagonia, Argentina: Rock magnetic and geochemical analyses

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Laguna Ñe Luan, also known as "Laguna Ojo de Guanaco", is located approximately 30 km south of Maquinchao in the central-southern region of Río Negro, Patagonia, Argentina. This study addresses the paleoenvironmental dynamics of the region by analyzing three sediment cores retrieved from the deepest part of the lake with a gravity corer. The composite sediment record is 2 m long and provides a unique opportunity to study regional climatic variability and depositional environments in an underexplored area of Patagonia. This region is particularly important due to its latitudinal position, which makes it a valuable site for paleoclimate reconstruction, as the Southern Hemisphere is currently underrepresented in climate studies.

The sediment cores were split into halves. Spot magnetic susceptibility (k) measurements were taken on one of the half, and elemental composition was analyzed at a spatial resolution of 1 mm on the ITRAX XRF-CS using a Chromium (Cr) X-ray tube. Subsequently, the cores were sub-sampled. One half of the core was sub-sampled using cubic plastic boxes (8 cm^3) for rock magnetic analysis, while the other half was sampled every centimeter for geochemical analysis including total carbon (TC), total nitrogen (TN), and total sulfur (TS). Moreover, total organic carbon (TOC) and total inorganic carbon (TIC) was determined. The elemental composition and geochemical analyses were performed

at the GEOPOLAR Institute, University of Bremen. Preliminary geochemical results indicate interesting variations, including an increase in C, N, S, and TOC, and a decrease in magnetic susceptibility (k), especially towards the 30 cm top of the core. These trends are crucial for understanding how recent climate change is defined and contrasted with past climatic changes.

A comprehensive set of laboratory experiments will be conducted on each sample to characterize the magnetic properties of the sediments. The intensity and directions of natural remanent magnetization (NRM) will be measured, including declination (D) and inclination (I). Magnetic analyses will also include the acquisition of anhysteretic remanent magnetization (ARM) and isothermal remanent magnetization (IRM) up to saturation and hysteresis loops to study the magnetic mineralogy and grain size. All magnetic measurements will be conducted at the Institute de Physique du Globe de Paris (IPGP-Université Paris Cité), France.

An age-depth model will be constructed using ^{210}Pb and ^{137}Cs dating, complemented by radiocarbon dating. Paleomagnetic data will refine the chronology and reveal geomagnetic secular variation as additional markers. Notably, two tephra layers identified within the sedimentary sequence will serve as chronological constraints and provide insights into regional volcanic activity.

This multidisciplinary study offers a comprehensive understanding of the environmental history of Laguna Ñe Luan, contributing paleoclimate data for Patagonia. By integrating rock magnetic and geochemical analyses, we will uncover new insights into climatic and depositional processes that have shaped this region over the past millennia.

Keywords: Paleoenvironmental reconstruction, Geochemical analyses, Rock magnetism, Lake sediments, Patagonia

【A0286】

Palynological analysis of modern and archeological ungulate feces: Investigating taxonomic diversity and agropastoral practices in a little explored Andean area from South America

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The pollen content of paleofeces is a valuable reservoir of paleobiological and cultural information. In South America, palynological studies have been conducted on ungulate paleofeces in Patagonia, but few studies have been performed in the South-Central Andes, a region with a long history of human-camelid interactions. Here, we present an exploratory study in El Bolsón (Catamarca, Argentina), an Andean high-altitude valley, aimed at assessing whether pollen spectra of Holocene ungulate paleofeces varies across taxa and/or agropastoral management. Feces and paleofeces were collected, and pollen was extracted from the inner part of both samples. Pollen identification and counts were carried out using an optical microscope and reference collections.

We first conducted an actualistic study, analyzing modern feces and interviewing local populations about agro-pastoral practices to model pollen spectra in a known environmental and cultural context. We studied 12 feces of domestic llamas (*Lama glama*, n=3), goats (*Capra aegagrus hircus*, n=6), and sheep (*Ovis orientalis aries*, n=3) from different agro-pastoralist contexts in wet season. Most presented high total pollen concentration (>6000 grains/gr). Goat feces were dominated by dicotyledons, including *Asteraceae subf*. *Asteroideae* (68-80%) and *Fabaceae* (10-24%), while monocotyledons, particularly *Poaceae* (91-98%), were predominant in llama and sheep feces. Interviews revealed that goats are kept overnight and released in daytime, whereas the llamas and sheep are kept enclosed in the same corral, where *monocotyledons* prevail.

For the archaeological application, we studied ungulate paleofeces from Los Viscos rockshelter (2464 masl), containing occupations spanning the last 1200 years. The zooarchaeological record suggests the historical importance of camelids, including vicuñas (*Vicugna vicugna*) and domestic llamas, unlike the modern dominance of European livestock. We selected 3 paleofeces from a stratigraphic unit radiocarbon-dated to 590±50 ^{14}C BP -one of which is an aggregate of at least three pellets crushed together.

All samples were morphologically compatible with *Artiodactyla*. Unlike modern samples, paleofeces had low pollen concentration (<1000 grains/gr), except for the aggregated one (14453 grains/gr), which may relate to ecological, cultural, or taphonomic differences. Identified pollen types included Poaceae, Asteraceae subf. *Asteroideae*, *Chenopodiaceae*/*Amaranthaceae*, and *Lentibulariaceae*, among others.

We also compared these results with paleofeces of the same period from a previous multiproxy study at the site, where one pellet was a DNA-identified as goat (Petrigh *et al.* 2021). Low pollen concentration and similar pollen types were also found. Paleofeces pollen spectra are consistent with that of the modern goat sample, suggesting that these past animals probably were not enclosed in *monocotyledon*-dominated areas, as in the modern sheep and llama corral, and may have been wild or else handled under other conditions.

This new study contributes to the palynological analysis of late Holocene paleofeces from Andean South America. The results suggest that variability in feces pollen may be more influenced by agro-pastoralist practices than by taxonomic variation. They also highlight the importance of ethnographically-informed modern analogs in interpreting paleofeces. Future research will focus on broadening the modern sample to include seasonal variation and paleofeces from different site areas and stratigraphic units.

References:

Petrigh, R, S., Velázquez, N, J., Fugassa, M, H., Burry, L, S., Mondini, M., Korstanje, M, A., 2021. Herbivore coprolites from the south-central Andes. A multiproxy study at los Viscos archaeological site, Catamarca, Argentina. Journal of Archaeological Science: Reports 38, 103063.

Keywords: Paleofeces, Feces, Pollen, South-central Andes, Camelids

【A0018】

Responses of Amazonian vegetation to a slowdown of the Atlantic Meridional Overturning Circulation: Past perspectives and future insights

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The Atlantic Meridional Overturning Circulation (AMOC) and the Amazon forest are viewed as connected tipping elements in a warming climate system. If global warming exceeds a critical threshold, the AMOC may slow down substantially, changing atmospheric circulation and leading to Amazonia becoming drier in the north and wetter in the south. Yet, the impact of an AMOC slowdown on Amazon vegetation is still not well-constrained. Here, we investigate Amazonian vegetation and fire responses from 25,000 to 12,500 years ago, encompassing a past major AMOC slowdown (Heinrich stadial 1, from 18,000 to 14,800 years ago), based on pollen and microcharcoal analyses of a marine sediment core and species distribution models forced by distinct climate scenarios. Additionally, we model vegetation responses to an AMOC slowdown considering pre-industrial conditions. During the Last Glacial Maximum (23,000 to 19,000 years ago), despite lower atmospheric CO_2 and relatively drier conditions, the Amazonian landscape remained predominantly forested with a notable expansion of cold- and moisture-affinity tree species driven by significantly colder temperatures. Subsequently, during Heinrich stadial 1 AMOC slowdown, pollen data reveal a decline in cold- and moist- affinity

elements, coupled with a rise in seasonal tropical vegetation. This pattern is consistent with the decline in suitability of northern Amazon moist forests in a model with an imposed 50% AMOC weakening under glacial boundary conditions. Our modelling shows that a comparable AMOC slowdown under pre-industrial conditions would also trigger a decrease in precipitation over northern Amazonia, increasing the vulnerability of forest formations there. Combined with ongoing disturbances across the basin, including deforestation and shifts in rainfall regimes, this northern increase in forest vulnerability linked to the AMOC slowdown could have a systemic impact on the Amazon ecosystem if anthropogenic forcings remain unabated.

Keywords: Amazon, Atlantic Meridional Overturning Circulation, Palynology, Heinrich Stadial 1, Microcharcoal

【A0256】

Mesoscale convective systems from the Cenozoic into the future: Insights from high-resolution community Earth system model simulations

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High-resolution climate models are essential for resolving finer-scale weather systems, which are critical for predicting the impacts of climate change. Mesoscale Convective Systems (MCSs), defined as organized clusters of thunderstorms, are prominent features of global precipitation, contributing more than half of total precipitation in the tropics and some midlatitude regions. However, studying MCSs across Earth's history, especially in paleoclimate contexts, has been limited by computational constraints. This project aims to track MCSs during key Cenozoic intervals, including the Last Glacial Maximum (~21 ka;

190 ppm CO_2), mid-Pliocene Warm Period (~3.2 Ma; 400 ppm CO_2), and Early Eocene Climatic Optimum (~50 Ma; 840 and 1680 ppm CO_2), as well as a preindustrial control (284.7 ppm CO_2). These paleoclimate intervals were selected to capture a range of different climate states, from icehouse to hothouse climates. This study uses a new set of isotope-enabled Community Earth System Model 1.3 simulations, with ~0.25° atmospheric and land resolution and ~0.1° ocean and sea ice resolution. These simulations allow for the development and evolution of organized MCSs and meso-scale ocean eddies, which have never been explored in the context of coupled paleoclimate systems. In addition, we employ a deep learning model utilizing the U-Net architecture for image segmentation, trained on ERA5 reanalysis data, in combination with Tempest Extremes, an adaptable feature-tracking algorithm, to detect and track MCSs within these simulations.

This study investigates whether changes in MCS characteristics scale with global mean temperature, similar to patterns observed in extreme precipitation events. Preliminary results indicate a poleward expansion in MCS activity with increasing atmospheric CO_2, accompanied by a general increase in MCS precipitation and a higher contribution of MCSs to annual total precipitation. Furthermore, we find that higher surface temperatures correspond to elevated levels of outgoing longwave radiation and brightness temperature, indicating the presence of warmer high cloud tops associated with these storm systems. This change in cloud-top temperature, a commonly used metric for tracking MCSs, suggests a shift in the characteristics that define these storm systems compared to present-day conditions. By examining MCSs across these diverse climate states, we aim to further uncover patterns and relationships between storm characteristics and global temperature. This research will provide valuable insights into past hydroclimate changes and contribute to more accurate predictions of future MCS behavior in a warming world. Ongoing work will compare these results with a high-emission RCP8.5 global warming scenario to better understand how MCS behavior will respond to future warming.

Keywords: Hydroclimate, High-resolution modeling, Extreme events

【A0329】

Reconstruction of the hydroclimate variability in the southern Andaman Sea over the last 110 ka

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The southern Andaman Sea, located near the equator within the Indo-Pacific Warm Pool (IPWP), offers an ideal location for studying past changes in convection over the IPWP and the influence of the Walker Circulation. Currently, the Andaman Sea receives freshwater from both precipitation and runoff during the Indian Summer Monsoon (ISM) season, leading to significant seasonal variations in sea surface salinity (SSS) and oxygen isotope ratio ($\delta^{18}O_{sw}$). To reconstruct changes in sea-surface temperature (SST) and $\delta^{18}O_{sw}$ over the last climatic cycle (110 ka), we analyzed Mg/Ca ratios and $\delta^{18}O$ from the planktonic foraminifera *Globigerinoides ruber* ss in core BAR94-25.

Our data show that changes in $\delta^{18}O_{sw}$ (which we use as a proxy for SSS) are primarily driven by the precession cycle (23 ka), with an in-phase relationship with boreal autumn insolation. SSS is out of phase (lag ~ 4.5 ka) with the Chinese stalagmite $\delta^{18}O$ record, which is sensitive to the East Asian Summer Monsoon (EASM). To further explore the connection to the El Niño-Southern Oscillation (ENSO) and the Indian Ocean Dipole (IOD), we compared our $\delta^{18}O_{sw}$ record with a published ENSO index, and an IOD index that we reconstructed. Our findings reveal that decreases in $\delta^{18}O_{sw}$ – indicative of fresher sea surface waters – occur during periods dominated by La Niña-like and/or positive IOD-like conditions, coinciding with intervals of increased fall insolation and enhanced Walker convection. Conversely, significant increases in $\delta^{18}O_{sw}$ – corresponding to higher SSS – are observed during periods dominated by El Niño-like and negative IOD-like conditions.

Within the precession band, the in-phase relationship between our $\delta^{18}O_{sw}$ record, the ENSO index, and the IOD-like index suggests an interaction between the equatorial western Pacific and the eastern Indian Ocean mediated by the Walker Circulation system. Atmospheric convection and ENSO-IOD dynamics appear to have played a crucial role in regulating rainfall in the Andaman Sea region. Other long records of the IOD are needed

to better understand the interactions of the IOD with ENSO and the Asian monsoon system at the precessional orbital timescale.

Keywords: Paleoceanography, ENSO, IOD, Foraminifera, Salinity

【A0547】

Deciphering climate patterns across the last glacial-interglacial transition in Northwest Africa: Insights from speleothems

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We conducted a high-resolution paleoclimate record from a stalagmite sample in Northwest Africa to capture hydroclimate variability over the past 34,000 years. The age model, constructed with over 80 ^{230}Th dates and 2076 $\delta^{18}O$ and $\delta^{13}C$ datapoints, reveals periods of mineralogical transitions aligned with significant climatic phases, such as the Last Glacial Maximum (LGM) and Holocene. $\delta^{18}O$ and $\delta^{13}C$ records show a long-term decline with a significant positive correlation ($r = 0.82$, $p < 0.001$). Data cluster into three groups across key intervals (Holocene, Younger Dryas, B/A-MIS 3), with $\delta^{18}O$ amplitude of 1.72‰. On a multimillennial scale, $\delta^{18}O$ and $\delta^{13}C$ exhibit opposite trends in some key intervals, notably during the Last Termination and part of MIS 3. Additionally, variations in Sr/Ca and Mg/Ca in the calcite interval (YD-LGM) hint at the role of water-rock interactions and effective rainfall with minimum contribution from prior carbonate precipitation. Comparisons with regional paleorecords reveal the record sensitivity to orbital and millennial-scale climate oscillations, highlighting a response to both global boundary conditions, such as radiative forcing and AMOC variability, and local factors,

including the influence of Mediterranean-derived moisture, typically during the LGM. The study presents the first high-resolution speleothem record from Northwest Africa to offer insights into regional hydrological responses to broader climate dynamics during the Last Glacial-Interglacial Transition.

Keywords: Speleothems, Late Glacial Maximum, Last termination, Northwest Africa

【A0530】

Holocene environmental changes in Morocco: A comprehensive database

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Holocene environmental changes in Morocco have been reconstructed on the basis of published paleoclimate records from different natural archives. Herein, we present a comprehensive database that includes Holocene records from speleothems, lake sediments, tree-rings, and marine sediments. The Holocene in Morocco has been a period of important environmental and climatic change, impacted by natural forces and human activity. During the early Holocene (11.7–8 ka BP), warm and humid conditions associated with the African Humid Period led to abundant vegetation and high lake levels, especially in the Middle Atlas. By the mid-Holocene (8–4.2 ka BP), the climate began to dry as the monsoonal rains retreated southward and the Azores High increased, bringing an aridification across both northern and southern Morocco. Around 4.2 ka BP, an abrupt aridification event generated widespread environmental shifts, including declining lake levels and changes in vegetation patterns. The late Holocene (4.2 ka BP to the present) had more climate variability, alternating between wetter and drier periods. Periods include the Medieval Climate Anomaly (900–1300 AD), characterized by drier conditions, and the Little Ice Age (1300–1850 AD), marked by cooler and wetter conditions in some areas. During this period, human impacts became more evident. Moreover, the Arabization of Morocco around 600–700 AD introduced new agricultural practices and land-use strategies that transformed landscapes, contributing to deforestation and soil erosion.

Keywords: Holocene, Morocco, Paleoclimate, Human impact

【A0564】

Wine, vagrants and volcanoes: Impacts of 17th Century multi-eruption events on municipal hospitals in early modern Switzerland

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Recent research identifies three major tropical volcanic eruptions of the 17th Century as double or multiple eruption events: *Huaynaputina/Paektu (1600), Koma-ga-take/Mt. Parker (1640/1641),* and *the quadruple Unknown Event (UE) of the 1690s*. While eruptions with significant climatic and societal impacts have been extensively analysed, particularly in vulnerable regions, less attention has been given to the potential teleconnections of multi-eruption events in regions with less pronounced climatic effects.

This paper adopts a transdisciplinary approach to examine the climatic and societal impacts of these three multi-eruption events on early modern hospitals in eastern and western Switzerland. As principal welfare institutions in many European cities, hospitals depended on harvest income to feed their residents, making them especially vulnerable to climate anomalies.

Using the newly developed web data processing tool ClimeApp, the climatic impact is assessed with the most modern climate reconstruction data from the ModE-RA project. Novel archival material from three municipal hospitals – *Hôpital des bourgeois de Fribourg*, *Heilig-Geist-Spital in St. Gallen*, and *Burgerspital in Bern* – provides annually recorded harvest yields, particularly for viticulture and caseiculture, allowing for an analysis of potential interrelations. Key sources, such as the ***Ratsmanuale*** (protocols) and ***Mandatenbücher*** (regulations), shed light on whether the municipalities of Fribourg, Bern, and St. Gallen implemented measures or coping mechanisms in response to these eruptions and how these strategies evolved over a century.

This study contributes to a deeper understanding of the agricultural and societal impacts of multi-eruption events over nearly a hundred years in the same region.

Keywords: Volcanic eruptions, Viticulture, Caseiculture, Hospitals

【A0199】

Parasites in rodent middens as indicators of ecological and environmental dynamics during the Late Quaternary in the Atacama Desert

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Paleoparasitology, the study of parasites in archaeological and paleontological contexts, provides valuable insights into paleoecological, evolutionary, and cultural dynamics. Parasites serve as robust indicators for reconstructing past environments, offering information on climate, diet, hygiene, demography, host-parasite relationships, and paleoepidemiology. By studying their presence in ancient contexts, research in this field infers environmental conditions and ecological interactions that shaped past ecosystems. Primary sources for paleoparasitological studies include coprolites, rodent middens, pellets, sediments, and other remains from diverse organisms. Rodent middens, in particular, consist of plant macrofossils, coprolites, pollen, and sediments encased in hardened urine, forming deposits that can remain intact for millennia. In South America, these deposits have been central to paleoenvironmental and paleoclimatic studies spanning the last 50,000 years, specially in the Atacama Desert, characterized by prolonged hyper-arid conditions. Early research focused on plant remains and pollen, but advancements in recent decades expanded the scope to include proxies such as arthropod assemblages and heavy metal concentrations. These deposits have emerged as significant archives for paleoparasitological evidence in arid ecosystems, particularly in Argentina and Chile, where they are recognized as bioindicators of environmental conditions, offering new dimensions to paleoecological reconstructions. The present study aimed to explore the paleoparasitic diversity within rodent middens of the Atacama Desert and assess their potential as indicators of environmental changes during the Late

Quaternary. The analysis encompassed 150 rodent middens distributed across latitudinal (18°S to 25°S) and altitudinal (2,000 to 6,600 m a.s.l.) gradients, with dating ranging from hundreds of years to 12,000 years cal BP. Using coprological and molecular methodologies, including ancient DNA techniques, hosts and their parasites were identified. Strict protocols were implemented to avoid contamination and ensure data integrity. Multivariate statistical analyses revealed patterns of parasite abundance, diversity, and intensity linked to environmental variability over time and space, as well as parasite adaptations to extreme conditions. Results identified a high diversity of parasites, including nematodes, cestodes, and coccidia, with distinct assemblages across spatial and temporal scales. Latitudinal and altitudinal variations in parasite communities, particularly in more recent samples, aligned with current environmental productivity gradients, providing new insights into parasite-host spatial dynamics and the environmental factors that have dominated the desert in recent years. In contrast, parasites in ancient samples varied in response to fluctuations in environmental conditions in the region over the last several thousand years. These findings highlight the resilience and adaptation of parasites and their rodent hosts to the Atacama Desert's extreme conditions, as well as the influence of fluctuating environments on parasite assemblages. This study underscores the utility of parasites as proxies for reconstructing past environmental conditions. It expands the geographic and temporal scope of paleoparasitological research, integrating this field with other paleoecological proxies, enriching our understanding of ancient parasitic infections. This research offers innovative contributions to paleoecology and paleoenvironmental studies. Expanding this approach will enable deeper reconstructions of ancient environments and provide insights into how past societies and wildlife adapted to environmental changes, with implications for ecological and health challenges in arid regions.

Keywords: Paleoparasitology, Ancient ecosystems, Coprolites, South America, Environmental change

【A0242】

Cautionary tales in paleoproductivity reconstruction: A case study from the Bay of Bengal

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By comparing the paleoproductivity proxies from the Bay of Bengal, we infer that constraining productivity through a single proxy might lead to overestimation/underestimation. As a critical climate modulator, primary productivity controls the exchange of CO_2 between the ocean and the atmosphere (Broecker, 1982). Many factors, including nutrient availability, turbidity, and light and wind intensity, influence the oceanic primary productivity. Therefore, primary productivity signatures are often used to assess the changes in hydroclimate variability in a particular region. This makes the paleoproductivity records an essential aspect to understand the climate change in different boundary conditions. The past productivity changes have been constructed by using different proxies like planktic foraminifera, benthic foraminifera, biogenic opal, organic proxies and carbonate content. However, due to different regional biases associated with different proxies, the inferences obtained from a single proxy often result in misinterpretation. To address this, we will present a carbonate based multiproxy record of glacial-interglacial productivity changes from IODP Site U1446 in the northern Bay of Bengal which is characterized by a river runoff driven productivity. This study aims to untangle the complexities associated with different proxies used to assess glacial-interglacial productivity changes on a regional scale. For this we have used the absolute abundance of planktic foraminifera, the ratio of *Globigerina bulloides* to *Globigerinoides ruber*, Eutrophic assemblage based on planktic foraminifera species population and Cd/Ca in surface dwelling *G. ruber*. The Li/Ca values of *G. ruber* have been used to differentiate the signature of carbonate preservation from productivity. We also compared our productivity record with the published record of seawater $\delta^{18}O$, $\delta^{13}C$ of leaf wax, Rb/Ca and pCO_2 from the same site. The data for the last ~1.45 myr shows increased productivity during interglacials and increased carbonate preservation during glacial periods. Our proxy comparison infers differential control of hydrodynamic conditions on different productivity proxies. So, we suggest caution should be exercised while interpreting single proxy based paleoproductivity changes on a regional scale.

Keywords: MPT, Primary productivity, Indian Ocean, Glacial-interglacial, Foraminifera

【A0225】

Indo-Pacific climate variability modulates subsurface temperature variability recorded in Andaman Sea corals during the last centuries

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The Indo-Pacific region is surrounded by highly populated areas that are susceptible to climate extremes, like floods, droughts, and heatwaves. Timing and severity of these extremes are influenced by the Asian monsoon, Indian Ocean Dipole (IOD), El Niño-Southern Oscillation (ENSO), and Indo-Pacific inter-basin interactions. Sea Surface Temperature (SST) is one of the main drivers of basin-wide climate extremes and therefore an essential metric to understand. Historical SST products suffer from sparse coverage and high uncertainty before the 1960s. Improvements on these products from satellite measurements are available since the 1980s but are limited to the upper few mm of the water column. Consequently, assessments of subsurface temperature variability on interannual to multidecadal timescales under past and present climate change remain difficult. The carbonate skeletons of massive shallow-water corals provide continuous records of subsurface temperature that complement SST observations and provide insights into ocean-atmosphere dynamics of the shallow ocean.

Here we present monthly-resolved records of the Sr/Ca-temperature proxy from *Porites* corals of the southern Andaman Sea (Ko Racha Yai, Thailand, ~7.6°N), northeastern Indian Ocean. Coral Sr/Ca tracks the variability and annual cycle of high-resolution (~5 km x 5 km) satellite SST fairly well during the calibration period, including a double-peak in spring and fall SST resulting from regular monsoonal forcing. In some years, coral Sr/Ca indicates prominent events of exaggerated cooling in late fall and winter that are not apparent in the satellite SST. These events coincide with years of combined positive IOD (pIOD) and El Niño events (1994-95, 1997-98, 2006-07), as well as one La Niña event (1999-00). These Sr/Ca-based cooling events are evident in cores of single and of different *Porites* corals, highlighting intra- and inter-colony reproducibility. These anomalous events across multiple temperature proxy records, capture a distinct

IOD signal in an area which based on historical and satellite SST products is normally considered too far north of the eastern node of the IOD to be impacted.

The prominent cooling events in coral Sr/Ca, relative to satellite SST, can be best explained by subsurface exposure to large-amplitude internal waves (LAIW). In the Andaman Sea, LAIW transports colder subthermocline water up to the depth where corals grow (5-10 m), but rarely to the sea surface where satellite SST is monitored. We show that the reef cooling by LAIW varies on interannual to decadal timescales, likely due to thermocline variations caused by the IOD, ENSO, and Asian monsoon. Combined pIOD and El Niño events along with a weaker Asian summer monsoon may cause stronger upwelling Kelvin waves from the equatorial eastern Indian Ocean, resulting in a shallower thermocline and thus stronger LAIW-cooling of the Andaman Sea coral reefs. We will present a monthly coral Sr/Ca reconstruction of northeastern Indian Ocean shallow subsurface temperature back into the pre-instrumental era, to investigate these mechanisms on decadal to multidecadal timescales. Our results will provide unique insights into ocean-atmosphere interactions of northeastern Indian Ocean subsurface temperature and Indo-Pacific climate variability over the last centuries.

Keywords: Indo-Pacific climate, Andaman Sea, Subsurface temperature variability, Coral Sr/Ca

【A0796】

Examining the role of the Pacific Ocean in the unusual warming of the western Indian Ocean over past century

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The Western Indian Ocean (WIO) has undergone rapid warming over the past century, surpassing that in other tropical Indo-Pacific Ocean basins. Warming in the Indian Ocean is often associated with El Niño conditions. El Niño events transfer warm anomalies from

the Pacific to the Indian Ocean through a series of ocean-atmosphere interactions, accumulating heat in the WIO. In this study, we use coral datasets in the WIO to reconstruct regional sea surface temperature (SST) from 1846 to 2006, and employ different ensembles from the Community Earth System Model to test the Pacific's role in driving WIO warming. Our coral-based reconstructions show a significant warming of approximately 1°C in the WIO after the 1920s, coinciding with more frequent and stronger El Niño events. In the large ensemble (1920-2014) and Last Millennium Ensemble (1920-2005), the WIO is not the fastest-warming region in the tropical Indo-Pacific Ocean. Although these models reflect the intensification of El Niño events by showing an increase in the eastern Pacific SST standard deviation, they fail to replicate the enhanced eastern Pacific SST skewness observed in the instrumental SST data (ERSST and HadISST). A Pacific pacemaker ensemble (1920-2014, using observed SST in the tropical Pacific) displays the skewness that is inherent in the experimental design, but WIO warming is still weaker than observed. Additionally, the Indo-Pacific interaction in the coral reconstructions exhibits decadal variability, with different decades characterized by distinct combinations of physical mechanisms. Although the models generally capture the dynamical mechanisms observed in recent decades, they lack the decadal modulations in Indo-Pacific interaction. The models' biases in representing the long-term changes in ENSO and decadal variations in Indo-Pacific interaction likely contribute to their underestimation of WIO warming.

Keywords: Western Indian Ocean, Warming, Indo-Pacific interaction, Community Earth System Model, Coral-based reconstruction

【A0204】

Protecting the future by learning from the past: Salmon nursery lake ecosystem reconstruction through sedimentary DNA

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Long-term data are crucial for understanding past environmental changes, establishing restoration baselines, and identifying stressors. Sedimentary DNA (sedDNA) has emerged as a powerful proxy in paleoecology, offering an expanded taxonomic scope compared to traditional methods. In this study, we used sedDNA to reconstruct ecosystem changes in salmon nursery lakes in British Columbia, Canada, spanning centuries to millennia. Using digital PCR (dPCR), we present the first DNA-based reconstruction of Sockeye Salmon biomass dynamics, uncovering distinct trends across the study lakes. DNA metabarcoding, targeting the 18S ribosomal RNA gene, was used to track shifts in microeukaryote communities, including phytoplankton, zooplankton, and other groups. Most lakes exhibited notable changes in algal communities, such as a relative increase in diatom abundance, a decline in chlorophytes, and fluctuating *chrysophyte* and *dinoflagellate* populations. Among diatoms, we observed a pronounced increase in planktonic species in surface sediments, likely reflecting longer open-water periods and/or enhanced thermal stratification. Additionally, we detected dynamic changes in potential fish parasites, such as *nematodes* and *ichthyosporeans*. *Nematode* reads displayed a consistent upward trend across all lakes, possibly indicating increased fish infection rates in recent decades. Network analysis identified novel indicator taxa, including *Pirsoniales* (diatom parasitoids), *Desmodesmus* (green algae), and *Glissomodida* (bacterivorous protists), and their historical abundances were reconstructed. Our findings demonstrate that sedDNA captures diverse taxa, enabling comprehensive ecosystem reconstructions and offering critical insights into aquatic ecosystem health. In collaboration with Fisheries and Oceans Canada and local Indigenous Peoples, these results inform conservation strategies to protect these vital salmon nursery lakes.

Keywords: Sedimentary DNA, Salmon, Digital PCR, Metabarcoding

【A0623】

Concurrent Pan-Pacific decadal hydroclimate extremes driven by Pacific decadal variability over the last millennium

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North America, South America, Asia, and Australasia contain a large portion of the global population, agriculture, and economic activities. Decadal-scale hydroclimate anomalies in these areas, especially when they occur concurrently, can have significant impacts on food supplies, the economy, and populations locally and globally. Although prior studies have investigated the drivers and characteristics of decadal-scale hydroclimate changes in these areas, they are often limited to assessments in individual regions or focus on interannual changes. As such, whether the hydroclimate in these regions can change concurrently on decadal timescale and the drivers behind such anomalies remain elusive.

We analyze the Paleo Hydrodynamics Data Assimilation product (PHYDA) in the context of decadally synchronous hydroclimate anomalies in these regions, and their associated sea surface temperature (SST) patterns. We identify decadally coherent hydroclimate anomalies on these continents with a spatial expression that is distinct from anomalies on interannual timescales. We particularly note the opposite phasing of hydroclimate anomalies in India, Australia, the southwestern regions of North and South America, and subsequently use these regions to identify concurrent hydroclimate extremes. We find that these decadally concurrent extremes are associated with SST changes that resemble Pacific Decadal Variability (PDV). However, there are also periods where shifts in PDV do not result in coherent pan-Pacific hydroclimate extremes. We further explore the relative role of changing interannual and decadal variability of the Pacific in causing pan-Pacific hydroclimate extremes and in driving the inconsistent relationship between PDV and pan-Pacific hydroclimate over time. We also supplement these analyses with model simulations to better determine the dynamic causes, as well as other paleoclimate field reconstructions to assess the dependency of these results.

Keywords: Hydroclimate, Pacific, Concurrent extremes, Common Era, Decadal variability

【A0200】

Sedimentary DNA reveals historical cyanobacterial responses to environmental and anthropogenic changes

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The Masurian Lake District in north-east Poland, contains more than 2000 lakes with diverse morphologies, land-use histories and varying trophic states, in an area of outstanding beauty and significant touristic value. Many of these lakes experience frequent *cyanobacterial* algal blooms during the growing season, suffer from low water transparency, and undergo anthropogenic eutrophication.

Using a metabarcoding approach, we reconstructed up to 250 years of *cyanobacterial* history using 16S rRNA amplicons and algal pigments extracted from sediment cores from three lakes with differing catchment morphologies and histories. Building on our earlier research that identified shifts in toxigenic *cyanobacteria* through the analysis of *mcyE*/*ndaF* genes involved in microcystin and nodularin biosynthesis in one of these lakes, we linked changes in the *cyanobacterial* community to historical environmental and anthropogenic factors.

Our findings demonstrate the utility of sedimentary DNA analysis in understanding long-term *cyanobacterial* dynamics. These insights can inform contemporary restoration efforts by identifying historical baselines and assessing how anthropogenic impacts and environmental changes have influenced *cyanobacteria* over time.

Keywords: Microcystins, Metabarcoding, Environmental change, Eutrophication

【A0227】

30-years of palaeoenvironmental variation at the end of the Little Ice Age reconstructed from a giant clam shell from the northern Great Barrier Reef

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The end of the Little Ice Age (LIA) is regarded as the last significant cold period before the onset of the global warming trend since the Industrial Revolution. We use the shell of a 30-year lifespan giant clam (*Tridacna gigas*) that lived around 1800 CE to reconstruct environmental conditions on the northern Great Barrier Reef, southwest Pacific, prior to global warming. Stable isotope ($\delta^{18}O$, $\delta^{13}C$) and trace element proxies (Sr/Ca, Mg/Ca) from both the inner and outer shell layers are used to estimate sea-surface temperature (SST), rainfall variability, and ENSO events.

We compared isotope ($\delta^{18}O$, $\delta^{13}C$) and trace element proxies (Sr/Ca, Mg/Ca) from both the inner and outer shell layers to show that the $\delta^{18}O$ values of the inner shell layer have a consistent negative offset of 0.21 ‰ from the outer shell layer. The removal of this offset enables us to better utilise both layers of the shell to reconstruct longer and more reliable records. We used the combined $\delta^{18}O_{Shell}$ data to reconstruct palaeo-SSTs around the early 19th century, showing SST variation between 22.9 to 29.0 °C (mean = 25.5 °C). The mean SST in summer (December to February) was 26.8 °C, whilst the mean SST in winter (June to August) was 23.4 °C. We found a good correlation between outer shell $\delta^{13}C_{Shell}$ and local precipitation and used this to reconstruct the ENSO variability. Trace element proxies are too ambiguous to independently provide precise quantitative palaeoenvironmental reconstructions. Both Sr/Ca and Mg/Ca from the inner shell show

an increasing trend with shell age. The Mg/Ca of the outer shell shows great potential as a palaeothermometry proxy, however, more calibration is needed for future studies.

The reconstructed environment indicates that cooling at the end of LIA also extended to the Southern Hemisphere, at least in the Southwest Pacific. The average SST at the end of the LIA was approximately 1.2 °C lower than the present-day and this cooling was more significant in summer than in winter. Additionally, the northern GBR had a more distinct wet/dry seasonality during this period. Monthly shell-reconstructed SST and precipitation also opened a window into past ENSO variability.

After comparing the other palaeoenvironmental reconstruction records from both the western and eastern Pacific coasts, and higher latitudes in the Southern Hemisphere, we suggest that in the early 19th century, La Niña events prevailed. This trend led to deceased SSTs and wetter environmental conditions in the Southern Hemisphere. The records provide a better understanding of ENSO or climatic variation at the end of LIA and before modern global warming. However, comparisons with regional reconstructed environmental records shows spatial heterogeneity and also archive heterogeneity, therefore, we recommend more detailed local sub-annual palaeoenvironmental reconstructions from various regions and archives in the near future.

Keywords: *Tridacna*, Sclerochronology, Geochemistry, ENSO

【A0359】

Linking tephra layers to climate shifts: A multi-proximal approach from Björn drift contourite deposits (IODP expedition 395)

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The study of Late Pleistocene contourite drift sediments in the Björn Drift region, South of Iceland, offers a unique opportunity to investigate the interplay between volcanic activity, ocean circulation, and climatic transitions. This research focuses on the analysis of tephra layers interspersed within the sedimentary sequence between 20 and 70 meters below the seafloor. These layers act as precise time markers for volcanic events, allowing us to correlate these events with broader climatic cycles and oceanographic shifts. Visual interpretation reveals the thickness of these ash layers varies between 10s of a centimeter of very fine-grained size fractions. These are found to be mixed between bulk sediments comprised of silty clay with moderate bioturbation. Tephra layers in the sediments provide a chronological framework for understanding the timing of volcanic eruptions during the Late Pleistocene. Coupled with stable carbon ($\delta^{13}C$) and nitrogen ($\delta^{15}N$) isotopic data from bulk sediments, this study sheds light on the influence of volcanic activity on marine productivity, nutrient cycling, and the carbon cycle across glacial and interglacial periods. Foraminiferal assemblages, sensitive to sea surface temperature, salinity, and changes in ocean circulation, offer insights into the responses of marine ecosystems to volcanic and climatic events. Variations in foraminiferal species at Site U1554 particularly *Globigerina bulloides*, *Neogloboquadrina pachyderma*, *N. incompta,* and *Turborotalita qinqueloba* enable the reconstruction of past oceanographic conditions, particularly concerning a transition from colder to warmer surface waters. As ice sheets began to retreat from glacial to interglacial conditions, the reduction in pressure could have led to enhanced volcanic eruptions. This could increase tephra deposition in the marine core, contributing to the sedimentary record during a glacial period. By combining tephrochronology with stable isotope data, and foraminiferal analysis, this study provides a comprehensive view of the mechanisms driving climate variability during the Late Pleistocene. Our findings highlight the interconnectedness of volcanic forcing, ocean circulation, and marine ecosystem responses during glacial-interglacial transitions, offering valuable insights into the sensitivity of the North Atlantic to climatic and volcanic perturbations.

Keywords: Tephra layers, Volcanic ash, Bjorn drift, IODP 395, Climatic shifts

【A0336】

The impacts of an AMOC slowdown on Australasian hydroclimate during Heinrich 5 and the 8.2 ka event

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Dansgaard–Oeschger and Heinrich stadials during the Last Glacial Period were associated with a weakening of the Atlantic Meridional Overturning Circulation (AMOC). A similar event happened 8,200 years ago (8.2 ka) during the early Holocene, and was the last centennial-scale abrupt cooling event in the Northern Hemisphere due to an AMOC slowdown. The impacts of an AMOC slowdown on Atlantic temperature are relatively well understood from proxy reconstructions and model simulations, but the precipitation changes in the Indo-Pacific region are less certain. In this study, we use the Australian Earth System Model ACCESS-ESM1.5 (CMIP6/PMIP4 model) to investigate the Australasian hydroclimate response to an AMOC slowdown and shutdown during abrupt climate events under both past warm (interglacial) and cold (glacial) climate conditions. North Atlantic freshwater hosing experiments are performed under 8.2 ka and 49 ka (during Heinrich Stadial 5) boundary conditions. Changes in the Southern Hemisphere monsoon systems, including the Indo-Australian monsoon, are evaluated, as well as shifts in the Inter-tropical Convergence Zone. The simulations provide important information about the hydroclimate response to AMOC weakening under different background states. This may be helpful for predicting possible future impacts. The simulations are also compared with proxy reconstructions, which can further allow us to evaluate model sensitivity to AMOC variability.

Keywords: Heinrich stadials, 8.2 Ka event, Australasian hydroclimate, ACCESS-ESM1.5 model, AMOC slowdown

【A0684】

Planktonic foraminifera and temperature records highlight climatic changes on the southern Portuguese margin during the Early-to-Middle Pleistocene (1.54–0.75 Ma)

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The Pleistocene was marked by major changes in glacial-interglacial cycles, with a significant transition between 1.25 and 0.7 Ma. Prior to 1.25 Ma, 41-kyr obliquity cycles dominated, resulting in shorter and less intense glacial periods. After the Mid-Pleistocene Transition (MPT), 100-kyr cycles became dominant, leading to longer and more pronounced glacial-interglacial cycles. These changes reorganized temperature gradients, influencing planktonic foraminifera distributions and abundances.

Here, we provide evidence of millennial scale climate variations and their effects on planktonic foraminifera assemblages at IODP Site U1387 (36°48.32'N 7°43.13'W, 559 water depth), located on the southwestern Iberian margin. The aim is to reconstruct sea surface temperature (SST) trends, based on the foraminiferal fauna and lipid biomarkers, and analyze ecological changes from MIS 52 to MIS 18 (1.54–0.75 Ma), spanning the transition from the 41-kyr to 100-kyr climate regime.

During the 41-kyr world, subtropical and transitional species dominated. Subtropical symbiont-bearing foraminifera, including *Orbulina universa*, *Globigerinoides ruber*, and *Globigerinella siphonifera*, exhibited abundances of 20–40%, although with *G. siphonifera* peaking only during MIS 47. *O. universa* and *G. ruber* reached maxima between MIS 51 to

MIS 39 when SSTs were as warm as ~23°C in summer. The same pattern was observed in the transitional species *Globoconella inflata,* with abundances up to 60%, particularly during MIS 43. Subtropical species, including *Globigerina falconensis* and *Globigerinella calida*, and tropical species like *Globorotalia crassaformis*, also peaked during these periods but declined sharply during MIS 45, signaling a weaker interglacial with cooler SSTs (~21°C in summer; 16°C in winter).

During glacial periods (e.g., MIS 48, MIS 44, MIS 42, and MIS 40), species related to high nutrients, like *Globigerina bulloides*, reached percentages between 30% and 60%. The species *Globigerinita glutinata* also contributed up to 15%, pointing to upwelling and well-mixed waters. In contrast, after 1.25 Ma, during MIS 35 to MIS 18, *G. bulloides* and *G. glutinata* showed reduced abundances (<25% and <15%, respectively). This decline coincided with the emergence of thermocline dwellers like *Globorotalia scitula* and *Globorotalia truncatulinoides.* These species increased in abundance (5–8%) during glacials such as MIS 28, MIS 24, and MIS 18, potentially indicating weaker upwelling. *G. truncatulinoides* surpassed 5% abundance only after 1.25 Ma, whereas *G. scitula* followed a similar trend, linked to a southward shift of the Azores Front impacting nutrient availability during glacial times.

In contrast, during interglacial periods MIS 31, MIS 25, and the beginnings of MIS 21 and MIS 19, the subtropical species with a strong affinity to the warm and oligotrophic surface waters had a consistent abundance of >40%. Maximum SSTs rose to ~24.7°C in summer and 13.4°C in winter and 23.3°C as annual SST. The expansion of the subtropical gyre during interglacials likely influenced these assemblages and SST fluctuations.

Our results highlight dynamic shifts in oceanographic conditions before and after 1.25 Ma. The coupling of biological and climatic changes suggests enhanced altered nutrient availability, upwelling intensity, and subtropical water influence shaping marine plankton ecosystems during the Pleistocene.

Keywords: Iberian margin, Paleotemperature, Nutrient availability, EMPT

【A0361】

Reconstructing the past shifts in Southern Ocean fronts using the planktonic foraminiferal assemblages

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The Southern Ocean plays a vital role in regulating Earth's climate due to its unique hydrography, shaped by distinct water masses and frontal regimes. These fronts, characterized by rapid changes in physical properties such as temperature and salinity, are influenced by the eastward-flowing Antarctic Circumpolar Current (ACC), the largest ocean current in terms of volume and speed. Planktonic foraminifera inhabiting the upper water column are highly sensitive to such environmental variations and serve as valuable indicators for studying these dynamic systems. This study focuses on sediment core SK200/23, retrieved from the Polar Frontal Zone in the Indian sector of the Southern Ocean from the intermediate water depth (~1423 m). By analyzing the downcore abundance of planktonic foraminifera, the research aims to reconstruct shifts in hydrological fronts and variations in calcareous production during glacial and interglacial periods of the Late Quaternary. The variability in dominant foraminiferal species, such as *Neogloboquadrina pachyderma* and *Globigerina bulloides*, is used to track shifts in hydrological fronts during glacial-interglacial cycles. During the last glacial period, the northward shift of the Antarctic Polar Front (APF) is marked by a higher abundance (~80%) of cold-water species like *N. pachyderma* at the core site. In contrast, the Holocene is characterized by the dominance of the subtropical-subpolar species *G. bulloides* (~20%) and a decline in *N. pachyderma*, indicating a southward shift of the APF. Since the current core site is at intermediate water depth, the planktic foraminiferal concentration variability represents their water column production changes. Despite significant shifts in hydrological fronts during glacial and interglacial periods, the total planktonic foraminiferal concentration exhibits limited variability, except for a pronounced decline during the Last Glacial Maximum (LGM). This stability in planktonic foraminiferal production across climatic transitions suggests that carbonate production remained relatively stable across the climatic transitions. This observed stability in planktonic foraminiferal production may be attributed to the Antarctic Polar Front (APF) position, which consistently remained south of the core site. As a result, the region remained within the Polar Frontal Zone (PFZ) across both glacial and interglacial periods. However, the sharp decline in planktonic foraminiferal concentration during the Last Glacial Maximum

(LGM) likely reflects the northernmost position of the APF, coinciding with an increased diatom- or opal-rich sediments that diluted the foraminiferal concentration. The results highlight the utility of planktonic foraminifera as a sensitive indicator of past environmental changes, offering valuable insights into subpolar hydrological variability. By analyzing foraminiferal assemblages from sediment core SK200/23, this study highlights the dynamic nature of frontal systems and their response to climatic fluctuations. Furthermore, the findings emphasize the Southern Ocean's pivotal role in regulating glacial-interglacial biological productivity and carbon cycling during the Late Quaternary.

Keywords: Southern Ocean, Palaeoceanography, Planktonic foraminifera

【A0864】

Holocene environmental change in the northern Ecuadorian Andes: First insights from lake sediment archives

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Tropical high-mountain regions, which are biodiversity hotspots, are highly vulnerable to the impacts of anthropogenic climate change and biodiversity loss. For example, land degradation, deforestation, and freshwater depletion pose significant challenges for land management, closely linked to ecosystem and societal changes. Despite their importance, these regions remain underrepresented in paleoenvironmental research, highlighting the need for targeted studies. Our pilot study aims to address this knowledge gap by reconstructing Holocene landscape dynamics in the northern Ecuadorian Andes, a region of high ecological and cultural value, using natural lake sediment archives. We employed a multi-proxy approach, combining sub-bottom profiles (SBP) with a detailed analysis of short sediment cores from lakes San Pablo, Cuicocha (SBP only), Muertepungo (SBP only), and the Mojanda Lake Region, all located in the high-altitude region around Ecuador's capital Quito (3000-4000 m a.s.l.). Our analysis includes sedimentological descriptions, non-invasive techniques such as line-scan imaging, high-resolution magnetic susceptibility, and XRF-core scanning, as well as invasive analyses on sub-samples (at 1 cm intervals), including grain size, bulk mineralogy, bulk geochemistry, bioindicators, and macrocharcoal. Radiocarbon and tephra analysis were conducted on additional samples to establish a chronological framework. Preliminary results indicate notable differences among the studied lakes, reflected in distinct sediment layers with unique properties. These variations are being linked to shifts in water levels, temperature, and other factors. By integrating these initial findings with local knowledge from communities, this interdisciplinary project aims to establish a long-term, sustained co-production of knowledge and foster a collaborative approach to address the impacts of climate change and biodiversity loss in the northern Ecuadorian Andes.

Keywords: Palaeoenvironment, Ecuadorian lakes, Sub-bottom profiles, Sediment cores, Multi-proxy analysis

【A1037】

Exploring coccolith morphology proxies for assessing carbonate saturation changes

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The shape factor ks and its normalized variation (σ/mean ks), derived from the morphological attributes of *coccolithophores* from the *Noëlaerhabdaceae family* (*Emiliania huxleyi* > 2 µm and small *Gephyrocapsa* spp.), have emerged as innovative proxies for tracking changes in carbonate saturation (Ω_{Ca}). To explore this relationship and examine how *coccolithophore* calcification and preservation influence fossil morphology, we analyzed *coccolith* mass, length, thickness, and ks through laboratory dissolution experiments and surface sediment samples retrieved in a depth gradient (629 – 3809 m water depth). Using redundancy analysis (RDA), we investigated potential links between coccolith morphological attributes (length, volume, thickness, and ks shape factor) and environmental variables, including mean annual seawater temperature, salinity, nutrients, total alkalinity, total carbon dioxide, pH, carbonate partial pressure at 50 m depth, and Ω_{Ca} at bottom depth from the study area surface samples. The results have demonstrated that mean ks correlates strongly with Ω_{Ca} at bottom depths, explaining up to 47% of its variance. Furthermore, σ/mean ks enhances the sensitivity of dissolution assessments by capturing variability in the degree of size-selective dissolution and assemblage composition. The RDA confirms that Ω_{Ca} primarily drives morphological variations in *coccoliths*. Importantly, σ/mean ks complements mean ks by accounting for variations in *coccolith* size and morphology, providing a more nuanced understanding of dissolution processes. Applying these proxies not only quantifies dissolution intensity but also enables the reconstruction of changes in the carbonate system over time. While traditional carbonate chemistry proxies often face challenges due to ecological and physiological variability, ks and σ/mean ks offer a direct link to the saturation state of carbonate. This makes them particularly suitable for studying environments with complex carbonate dynamics or limited preservation of other calcifiers. Overall, the mean ks and σ/mean ks proxies provide a reliable framework for interpreting past and present carbonate dissolution, improving our capacity to understand the role of oceanic carbonate chemistry in the global carbon cycle. Their potential applications include evaluating dissolution processes across depth gradients and reconstructing past changes in carbonate saturation.

Keywords: Coccolith, Paleoproxy, Carbonate saturation, Carbonate dissolution

【A0755】

AMOC modulates ocean heat content during the last four deglaciations

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Deglaciations are the largest natural global warming events across the Quaternary. During these large-scale reorganizations of the climate system, the planet takes up vast amounts of energy, about half of which warms the global ocean. Thus, global ocean heat content (OHC), which is directly linked to mean ocean temperature (MOT) through the heat capacity of sea water, is a key metric for the determination of Earth's energy budget during the Quaternary.

Several climate modelling studies suggest that OHC not only changes in response to orbital-scale changes in ice-sheet extent and greenhouse gas concentrations, but that it is also modulated on millennial timescales by ocean circulation. Here, we present the first OHC record that covers the last four glacial terminations, the glacial maximum conditions prior to them, and their subsequent interglacials, based on noble gas ratios in the EDC ice core in better than 1000-year resolution.

Our record reveals significant millennial-scale OHC variability across all studied terminations. Comparison to AMOC proxy records reveals that these millennial-scale OHC changes are anti-correlated with AMOC strength, suggesting that the AMOC modulates OHC during the last four deglaciations. In our record, the millennial-scale OHC variability most prominently manifests itself in the form of OHC maxima at the end of Terminations II–IV, when MOT was up to 1.9 ± 0.2 °C warmer than the Holocene. Given the magnitude of these maxima, AMOC-induced millennial-scale OHC variability may be an important control of early-interglacial atmospheric CO_2, sea level, and climate.

Keywords: Ocean heat content, AMOC, Millennial variability, Deglaciation, Noble gases

【A0875】

Linked molecular and isotopic indicators of fire history, population, vegetation and climate change in the Maya lowlands

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Understanding past societal responses to climate change requires proxy indicators of human population, climate and land-use change. We apply a range of proxies to a lake sediment core from Laguna Itzan, a cenote adjacent to the ancient Maya population centre of Itzan, in order to examine the response of the lowland Maya to climatic and environmental change, which remains poorly understood. By combining molecular proxies for population (faecal stanols) and biomass burning (polycyclic aromatic hydrocarbons or PAHs) with isotopic analyses of plant wax n-alkanes as proxies for vegetation change ($\delta^{13}C$) and palaeohydrology ($\delta^{2}H$), we show the complex interplay of environmental and societal changes over 3300 years.

Faecal stanols suggest at least three periods of significant population decline associated with precipitation change, including between 3300 and 2900 cal yr BP and 1860-1670 cal yr BP, as well as the widely documented Terminal Classic drought (1220-1050 cal yr BP). The use of PAHs provides a record of fire history from both hearths as well as from vegetation burning associated with hypothesised slash and burn land clearance, or swidden, agriculture. Fire history can be linked with records of vegetation change inferred by $\delta^{13}C$ of n-alkanes, which fluctuate between more negative values associated with forest (C_3) vegetation and more positive values associated with maize (C_4) agriculture.

Our data show that population and land use appear to be variable, with a transition from generally more intense fire use and C_4 plant agriculture during the Preclassic (3500-2000 BP) to dense populations and reduced fire use during the Classic period. This is consistent with other evidence for a more urbanised and specialised society in the Classic (1600-1000 BP), and less changing land use over time. We do not find evidence extreme drought in the hydrogen isotope leaf wax record (δ^2H_{lw}) at this site, implying that climate change was not a primary driver of observed variability in land use or population. This suggests that climate change was not a major control on Maya societal development, and undermines the hypothesised link between drought and Classic Maya "collapse" since collapse is inferred to have begun in the southwest lowlands.

Keywords: Maya lowlands, Plant wax isotopes, Faecal stanols, Polycyclic aromatic hydrocarbons, Palaeoclimate

【A0517】

Stalagmite records of Holocene climate change on the Chinese Loess Plateau

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The speleothems in northern China are excellent archives for studying changes in the East Asian summer monsoon climates, as monsoon precipitation contribute the major fraction of the annual precipitation and is highly sensitive to the advancement and retreat of the summer monsoon front. Based on 32 U-Th dates, 826 sets of carbon and oxygen isotope measurements, and 181 sets of trace element analyses (Mg/Ca, Sr/Ca, Ba/Ca) attained

from two stalagmites, this study presents multi-proxy stalagmite records from the northern margin of the Chinese Loess Plateau, primarily covering the period from 9.6 to 5.9 ka BP (before present, referring the years before 1950 AD). The deposition of the stalagmites from Yixi Cave exhibits significant episodic variability, very likely reflecting changes in regional hydroclimates determined by both the precipitation and temperature. The main growth phases correspond to periods of high stalagmite cumulative growth frequency in Longfeng Cave, which align with the high lake-level periods in northern China, providing constraints on the timing of the Holocene optimum in the study area. The amplitude of the "8.2 ka BP event" is not prominently defined and other centennial-scale fluctuations with similar amplitude are also observed in the $\delta^{18}O$ record of this cave, suggesting that multiple processes influenced the $\delta^{18}O$ variations in stalagmites from the monsoon margin regions in northern China. Additionally, a comparison of multi-proxy indicators in the stalagmites, especially the centennial-scale component of $\delta^{18}O$, reveals a significant regime shift around 7.8 ka BP, implying that different stages within the Holocene optimum were governed by distinct primary factors.

Keywords: The northern China monsoon margin, Holocene optimum, Speleothems, East Asian summer monsoon

【A0133】

Warming-induced changes of dry-wet boundary in northern China

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The response of vegetation to past global warming, as revealed by geological records, can provide insights into future changes. We used a detailed compilation of published pollen records to produce dry-wet boundary changes across northern China for the Last Glacial Maximum (LGM), mid-Holocene, Last Interglacial (LIG), and mid-Pliocene, representing major changes in global temperature. The results showed that in the region east of 110° E,

the trend of the dry-wet boundary rotated anticlockwise by around 30°, 5° and 10°, during the warm periods of the mid-Holocene, LIG, and mid-Pliocene, relative to the LGM, mid-Holocene, and LIG, respectively. The climate simulation results also showed the successive anticlockwise rotation of the trend of the boundary in response to global warming, which is roughly consistent with geological records from this region. Contrary to the warming-induced northwestward shift observed in the boundary in the region east of 110° E, the boundary in the region west of 110° E showed a complex pattern of temporal changes: the boundary remained stationary during the mid-Holocene compared with the LGM, while it shifted northward during the LIG relative to the mid-Holocene, and it shifted southward during the mid-Pliocene relative to the LIG.

Our results demonstrate an enhanced east-west climatic contrast in northern China with increase global temperature. The climate simulation results also indicated that the Western Pacific Subtropical High shifted northward and extended westward with global warming, thereby inducing a northwestward shift in the East Asian Subtropical Monsoon. Overall, our results suggest that the eastern region of northern China will become wetter under a warmer climate, which will promote the shrinkage of sandy deserts in the region.

Keywords: Dry-wet boundary, East Asian summer monsoon, Past global warming, Northern China, Spatial climate pattern

【A0459】

Reconstructing atmospheric sea salt aerosol variability over 800,000 years using the EPICA Dome C ice core

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Sea salt aerosols play a critical role in the climate system, influencing the Earth's radiative balance both directly by scattering incoming radiation and absorbing outgoing radiation,

and indirectly by acting as cloud condensation nuclei. In the polar regions, both the open ocean and sea ice are sources of sea salt aerosols. However, the evolution of these sources on glacial-interglacial timescales, and how this controls the atmospheric concentrations of sea salt aerosols remains poorly understood.

We use a continuous record of sea salt sodium ($ssNa^+$) from the EPICA Dome C (EDC) ice core to investigate the long-term evolution of sea salt aerosols. This record is the oldest continuous ice core record, covering the past 800,000 years. High-resolution measurements of chemical impurities preserved within the ice were made using a continuous flow analysis (CFA) system, which allows for the reconstruction of the $ssNa^+$ and other chemical impurity records in 1 cm resolution. Even for the deepest sections of ice, where thinning reduces the time resolution, the high resolution of the measurements allows for the preservation of multi-decadal-scale variability .

The EDC ice core record shows a 2-4 fold increase in $ssNa^+$ concentrations in glacial periods compared with interglacials. This variability arises from the interplay of local accumulation changes, changes in source strength, and aerosol losses during transport through wet and dry deposition. For example, due to temporal changes in precipitation on top of the ice sheet the local atmospheric sea salt concentration/sea salt deposition flux changed only by a factor of 2-3. Moreover, during glacial periods, colder temperatures led to a reduction in the integrated precipitation and, thus, aerosol loss during transport. In turn, this leads to increased atmospheric concentrations at the ice core site, and consequently, higher concentrations preserved within the ice core.

We use a simple conceptual transport model to correct for atmospheric losses during transport, enabling the reconstruction of past atmospheric concentrations of sea salt aerosols. Using the model, we investigate how changes in the temperature gradient during glacial-interglacial periods impact aerosol atmospheric lifetimes and the inferred source region for sea salt aerosols being deposited at the EDC site. This approach provides insights into changes in source strength and the variability of sea salt aerosol concentrations in high-latitude climates over glacial timescales. Here, we present a reconstruction of atmospheric sea salt aerosol concentrations spanning the past 800,000 years. Model results indicate that much of the variability in $ssNa^+$ in the EDC ice core can be explained by reduced aerosol rainout during cold periods, however reconstructed

atmospheric concentrations also suggest that source strength was increased 1-2 fold during cold periods.

References:

Markle, B, R., Steig, E. J., Roe, G. H., Winckler, G., McConnell, J, R., 2018. Concomitant variability in high-latitude aerosols, water isotopes and the hydrologic cycle. Nature Geoscience 11, 853 – 859.

Röthlisberger, R., Mudelsee, M., Bigler, M., Angelis, M., de., Fischer, H., Hansson, M., Lambert, F., Masson-Delmotte, V., Sime, L., Udisti, R., Wolff, E, W., 2008. The Southern Hemisphere at glacial terminations: insights from the Dome C ice core. Climate of the Past 4, 345 – 356.

Keywords: Ice cores, Sea salt aerosols, Glacial cycles

【A0525】

East Antarctic ice sheet and solid earth response since Last Deglaciation: Evidences from lake sediments

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The East Antarctic Ice Sheet (EAIS) is vulnerable to future climate change and global sea level rise. However, significant uncertainties remain regarding its dynamics, particularly its response to sea level changes and interactions with the solid Earth. Understanding the past dynamics of the Ice Sheet is crucial for assessing ongoing glacial isostatic adjustment (GIA) and its potential impacts on both sea level and solid Earth response. This knowledge gap arises from a lack of understanding of the past relative sea level (RSL) changes and their causal factors, particularly after the last glacial maximum (LGM). Low-elevated lakes of coastal oases viz., Larsemann Hills, Vestfold Hills and Rauer Group record RSL changes in their sedimentary sequences. In particular, for Larsemann Hills (LH), the low-elevated coastal lakes record such signatures. Here, we analyzed two radiocarbon-dated sediment

cores (DL2 and DL3) from freshwater Lake Discussion (5 m above sea level (asl)), Larsemann Hills. DL2 spans 6–17.1 cal. kyr BP and DL3 covers 0–6 cal. kyr BP. Combined diatom analysis showed marine species dominance from 17.1 to 2.8 cal. Kyr BP suggested the lake was a marine basin. A brackish-water diatom revealed a transition occurred between 2.7 and 2.3 cal. kyr BP, followed by freshwater diatoms from 2.3 cal. kyr BP to present, indicating isolation from marine influences. Based on nearby Mochou Lake's (10m asl) lack of marine phases from deglaciation to recent, we hypothesize RSL in the LH ranged from 5 to 10 m asl from the Last Deglaciation to 2.7 cal. kyr BP. The persistence of Discussion Lake as a marine basin during the 123 m rise in eustatic sea level (ESL) and its transition to freshwater at 5 m asl since 2.7 cal. kyr BP suggests 128 m of isostatic uplift in the Larsemann Hills since the last deglaciation. During the deglaciation period, the highest upliftment rate occurred between 14.5 and 14 cal ka BP, which coincided with the $\delta^{18}O$ records of ice cores, exposure dates at the Rauer Group, and melting flux proxies indicating an increased retreat of the Lambert Glacier-Amery Ice Shelf system. During the Holocene, the highest isostatic upliftment rate was recorded from 11.2 to 9 cal. kyr BP, coinciding with the timings of accelerated retreat of the Amery Ice Shelf and EAIS, as evidenced by marine and proglacial lake records. The mechanism driving the retreat of the Amery Ice Shelf grounding line, which triggers rapid isostatic uplift of the EAIS, is believed to be the southward shift of the Southern Hemisphere Westerlies during Meltwater Pulse 1A and the early Holocene. This shift likely brought warm Circumpolar Deep Water closer to Antarctica. Our findings highlight the dynamic interplay between GIA, glacial retreat, and oceanic forcing, with significant regional variations throughout the deglaciation and Holocene.

Keywords: East Antarctic ice sheet, Last deglaciation, Relative sea level changes, Prydz bay, Amery ice shelf

【A0845】

Environmental and ecological impacts of European colonialism in South Asia

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South Asia is one of the most densely populated regions in the world and is on the frontline of efforts to balance rapid urbanisation, agricultural expansion, water resource management, and economic development with the increasingly unpredictable effects of climate change. The complexities of this balancing act underscore the urgent need to understand the long-term interactions between human societies and their environments. In particular, developing detailed historical records of land use changes and their impacts on ecosystems and socioeconomic systems is crucial for addressing contemporary challenges.

A crucial threshold in this historical narrative is the arrival of European colonial powers, starting in the 15th century, which marked a profound turning point in land use and settlement patterns in South Asia. However, compared to other parts of the world, the impacts of colonialism on land use, environmental systems, and demography in South Asia remain relatively understudied, especially from a multidisciplinary perspective. This gap in knowledge is especially apparent when considering the complex legacies of British colonialism in the region. The transformation of South Asia's landscapes and social systems during this period had long-lasting consequences that continue to shape the region's ecological and socioeconomic conditions today.

In this study, we synthesise evidence from a range of disciplines, including archaeology, environmental history, historical ecology, and palaeoecology, to explore the environmental and societal impacts of European colonialism in South Asia, with a particular focus on India and Sri Lanka. We examine the introduction of non-native plant and animal species, shifts in land use tied to colonial land tenure systems—such as the establishment of plantations—and changes in urban structure and dynamics. We also analyse climate data on temperature and precipitation from 1300-2000 CE, as well as the social tensions, famines, and economic disruptions that accompanied these environmental changes.

We argue that the colonial legacies of land use and resource management in South Asia have significantly shaped the region's current vulnerabilities to climate change. For

example, widespread deforestation, the replacement of biodiverse ecosystems with monoculture plantations, and the degradation of traditional water management systems during the colonial period have contributed to the ecological fragility and socioeconomic inequalities that persist today. At the same time, evidence of traditional land use practices that predate colonial interventions offers valuable insights into how sustainable and resilient systems might be revived or adapted for modern contexts.

Keywords: South Asia, Colonialism, Land use, Environment

【A0954】

On the potential of glaciochemical analysis of Joinville Island firn core for the sea ice reconstruction around the northern Antarctic Peninsula

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The Antarctic Peninsula is one of the fastest-warming regions on Earth, profoundly affecting its cryosphere and marine ecosystems. This study investigates the potential of glaciochemical records from two firn cores collected on Joinville Island to reconstruct sea ice variability and primary productivity in the northern Antarctic Peninsula from 1993 to 2005. Major ions, including Na^+, Cl^-, MSA, SO_4^{2-}, and others, were analyzed using ion chromatography, alongside isotopic ($\delta^{18}O$) measurements. The study identified significant correlations between ion concentrations and environmental parameters, with Na^+ and Cl^- strongly associated with wind strength and sea ice extent ($r = 0.59–0.66$), while MSA exhibited the highest correlation with sea ice dynamics ($r = 0.80$). The analysis revealed a net accumulation rate of 0.4 m water equivalent per year, with stratigraphy indicating post-depositional processes such as melting and refreezing that impact ion variability. Hierarchical clustering grouped ions based on their sources, with marine aerosols (e.g., Na^+, Cl^-) reflecting sea spray influence and biogenic compounds (e.g., MSA) linked to

primary productivity. The results underscore the region's sensitivity to climatic fluctuations, with changes in sea ice influencing phytoplankton blooms and marine sulfur cycles. This study refines the understanding of glaciochemical proxies for reconstructing past environmental conditions, emphasizing the complex interplay between atmospheric, oceanic, and cryospheric processes. By linking glaciochemical data to satellite-derived sea ice records, it highlights the utility of firn cores in tracking regional climate changes and their broader implications for polar ecosystems and global climate models.

Keywords: Glaciochemistry, Sea ice dynamics, Methanesulfonic Acid (MSA), Climate proxies, Environmental reconstruction

【A0229】

The precession cycles in East Asian stalagmite records before the MPT constrained by carbonate U-Pb dating

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Carbonate U-Pb geochronology has demonstrated immense potential in the field of geosciences. The Isotope Laboratory at Xi’an Jiaotong University has innovatively developed a U-Pb dating method by combining Laser Ablation and Isotopic Dilution (LA&ID-MC-ICPMS), based on research into Quaternary secondary carbonate geochronology from caves. This method integrates the high spatial resolution and rapid analysis capability of laser techniques with the precision and controllable sample requirements of isotopic dilution, establishing an efficient and accurate system for carbonate U-Pb geochronology.

Based on the obust, high-precision LA&ID techniques, a new stalagmite record from Sanbao Cave in Shennongjia, Hubei is obtained, we determined that SB20 grew between 1.25 and 1.50 million years ago, capturing approximately eight orbital cycles of $\delta^{18}O$ variation. This study represents the first $\delta^{18}O$ record established in East Asia’s monsoon region predating the Mid-Pleistocene Transition (MPT). The stalagmite record highlights

the dominant role of low-latitude monsoons, driven by solar radiation forcing, in shaping the East Asian climate and reveals distinct precession cycles.

Furthermore, through comparative simulations of climate differences between the Last Glacial Maximum (LGM) and the Pre-Industrial (PI) period, as well as between climate extremes (Pmin-Pmax), we found that summer (JJA) wind field intensity and precipitation in the East Asian monsoon region are primarily influenced by solar insolation. By correlating this with $\delta^{18}O$ records from stalagmites across the MPT, we conclude that the large-scale monsoon circulation reflected in stalagmite $\delta^{18}O$ is not directly controlled by ice sheet or greenhouse gas radiative forcing but rather by the combined effects of the Atlantic Meridional Overturning Circulation (AMOC) and seasonal insolation changes.

With global climate change research gaining increasing attention, our study synthesizes past scientific achievements to reveal the interaction between thermodynamic circulation systems dominated by high-latitude ice volume and dynamic circulation systems regulated by low-latitude monsoons. This work establishes a multi-faceted geoscientific framework and provides critical evidence for exploring the "high-low latitude" climate circulation theory within the context of orbital-scale climate dynamics.

Keywords: Carbonate U-Pb geochronology, MPT, Stalagmite records, Precession cycles

【A0105】

Rapid or gradual cultural change: Exploring the Bantu migration and its impacts on the indigenous communities in East and Southern Africa

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The Bantu migration is one of significant event occurred for about 4000/3000 BP in sub-Saharan Africa. The event involved movement of Bantu-agropastoralists group who traces their origin from Nigeria-Cameroon border and spread to other parts of Sub-Saharan Africa via Congo rainforest. The reason for such migration has remained debatable

however; it has been affiliated to environmental issues and increase of population pressure over the land. The nature of interaction between Bantu and indigenous communities is debated among archaeologists, linguists, historians, biologists, and ethnographers. While some scholars believe that the nature of interaction was associated with dislocation/absorption and replacement of indigenous (Later Stone Age Hunter-gatherers), other scholars believe on gradual cultural changes involving adoption/acculturation and diffusion. The current study presents such debates by bringing the empirical archaeological evidence from Southern Highlands of Tanzania whereby through stratigrahic analysis, material composition, and chronological considerations the study supports the acculturation mode of interactions for those two cultural groups. Such conclusion is supported by other secondary data derived from genetic, linguistic, and archaeological evidence done broadly Africa and the same region in specific.

Keywords: Bantu, Sub-Saharan Africa, Indigenous, Interaction

【A0310】

Orbitally paced local overprint of a global climate change: The Eocene-Oligocene transition in the Transylvanian Basin (Central Paratethys)

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The Eocene-Oligocene transition marks a crucial period in Earth's history, characterized by global cooling and the onset of permanent ice in Antarctica. This event had profound effects on the global oceans and marine biota, but its regional impact remains poorly understood in certain areas, such as the Transylvanian Basin (Romania). To address this knowledge gap, we examined a 35 m thick uppermost Eocene-lowermost Oligocene section of the Brebi Formation. We employed a multi-proxy methodology focused on the benthic foraminiferal assemblages and derived calcareous/agglutinated ratios and epifaunal/infaunal ratios, complemented with time series analysis for cyclostratigraphy, and stable isotope analysis ($\delta^{18}O$ and $\delta^{13}C$) on bulk sediment from the re-collected type section of the formation. Revising the stratigraphic framework established by Rusu et al. (1993), we incorporated planktonic foraminifera and nannoplankton data to refine the placement of the Eocene-Oligocene boundary. Our results reveal a distinctive difference between the Eocene and Oligocene assemblages, as evidenced by multivariate analyses, despite the lack of a major faunal turnover. Notably, the transition period (EOT) is detectable through multiple independent proxies, such as faunal shifts and changes in the cyclicity patterns and the sedimentation rate. From ~22 m upwards, the obliquity signal becomes stronger than the long eccentricity cycle, and between 12–23 m, we identified a disturbance zone marked by spectral noise, disrupted cycles, and significant changes in benthic foraminiferal assemblages. Within this disturbance zone, two minima in the abundance of *Heterolepa eoceana* coincide with peaks in *Gyroidinoides soldanii* and *Neoeponides schreibersii*, suggesting environmental fluctuations likely tied to pulsed food supply and reduced oxygen levels. These trends are corroborated by shifts in the calcareous/agglutinated ratio towards agglutinated forms and a corresponding increase in infaunal taxa, alongside pronounced drops in the dissolved oxygen level. Despite the decline in diversity during this interval, high evenness and low dominance indicate that this reduction is not due to a few dominant species, but rather caused by environmental stressors. Overall, while the Eocene-Oligocene transition in this restricted basin shows more subtle faunal changes compared to global records, multivariate analyses reveal nuanced ecological trends that mirror broader global cooling patterns. These findings suggest that the Transylvanian Basin experienced regionally distinct yet interconnected environmental shifts, reinforcing the complexity of the EOT at both local and global scales. Future work will aim to enhance the resolution of this dataset through further section correlation and analysis.

Keywords: Eocene-Oligocene transition, Central paratethys, Benthic foraminifera, Cyclostratigraphy

【A0664】

Impact of meteorological-scale phenomena on paleoclimate reconstructions: Uncertainties in stable water isotope variations in Antarctic ice cores due to synoptic-scale atmospheric circulation

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Water isotopes measured in inland Antarctic ice cores enable the reconstruction of the temperature variations over the past several hundred thousand years. Although ice core studies have assumed that ice cores record the mean state of inland Antarctica, potential biases in the cores related to episodic warm and moist air intrusions from mid-latitudes and associated extreme precipitation events in inland Antarctica have been debatable. To examine the influence of mid-latitude atmospheric circulation on inland Antarctic precipitation isotopes, we adopted a Japanese isotope-enabled atmospheric general circulation model for the present and past climates (the Last Glacial Maximum; LGM; ~21,000 years ago). We found synoptic circulations (high/low-pressure system) were key in transporting moisture toward inland Antarctica in both climates. These circulations, especially during the austral winter, led to extreme precipitation events associated with abrupt warming. They significantly biased isotope signals weighted by precipitation amounts. We also found that daily variations in precipitation isotopes at Dome Fuji Station were primarily controlled by the Southern Annular Mode, an indicator of the westerly winds. Our results imply that such meteorological time-scale phenomena are crucial in determining inland Antarctic precipitation isotopes and may induce bias in interpreting ice cores. We will also discuss the applicability of the same methods to other regions.

References:

Kino, K., Cauquoin, A., Okazaki, A., Oki, T., Yoshimura, K., 2024. Synoptic moisture intrusion provided heavy isotope precipitations in inland Antarctica during the Last Glacial Maximum. Geophysical Research Letters 51, e2024GL108191.

Kino, K., Okazaki, A., Cauquoin, A., Yoshimura, K., 2021. Contribution of the Southern Annular Mode to variations in water isotopes of daily precipitation at Dome Fuji, East Antarctica. Journal of Geophysical Research: Atmospheres 126, e2021JD035397.

Keywords: Multi-time scale, Antarctica, Ice core, Westerly wind, Extreme weather

【A0250】

Simulated tropical Atlantic-Pacific climate variability changes under Holocene and last interglacial boundary conditions

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It is still uncertain how the tropics will evolve under anthropogenic climate change. In order to better understand tropical Atlantic and Pacific dynamics, their teleconnections to the Caribbean basin and the link of seasonality and interannual variability under different background climate conditions, we combine an isotope-enabled climate model with proxy records of temperature and hydrology from tropical fossil corals. Motivated by the past warm climate time-windows covered by the coral records, we conducted time-slice simulations for the Pre-Industrial (PI) period, the Mid-Holocene (6 ka) and the Last Interglacial (124 ka) using the water and carbon isotope-enabled Community Earth System Model (iCESM) at a nominal horizontal resolution of 1° in the atmosphere, land, ocean and sea-ice components. Coral records from Bonaire Island in the southern Caribbean representing time-windows during the Mid-Holocene and the Last Interglacial are used for model-data comparison.

In response to the changes in orbital and greenhouse gas boundary conditions, both 6 ka and 124 ka simulations show distinct climate anomalies such as increased sea surface temperature (SST) seasonality in the Southern Caribbean, which is consistent with the coral records. Furthermore, in boreal summer over the tropical Atlantic, both simulations indicate a northward shift of the Intertropical Convergence Zone. The tropical eastern Pacific exhibits La Niña-like conditions in SST with a cooling by 0.4°C and 0.5°C during boreal winter for 6 ka and 124 ka, respectively, which is also evident from an increased zonal sea level pressure gradient as compared to PI. Additionally, both of our simulations reveal a statistically significant reduction in the interannual variability of SST in the Central Pacific and a significant increase in the Eastern Pacific, with 124 ka showing larger amplitudes of the anomalies by up to 20% relative to PI. In terms of the interaction between seasonality and interannual variability, previous work pointed to a link between Pacific SST interannual variability and Southern Caribbean SST seasonality under modern climate conditions. Whether this link also holds for past warm climate states will be discussed based on our simulations and available coral records from the Atlantic and Pacific. This will provide deeper insights into Atlantic-Pacific teleconnections under future climate warming.

Keywords: Climate variability, Tropical Atlantic-Pacific teleconnections, Model-data comparison, Holocene, Last interglacial

【A0429】

The stalagmite-inferred interplay between the westerlies and the Indian summer monsoon on centennial to decadal scales over the south-western Tibetan Plateau during the last interglacial

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Climate variability on centennial to decadal scales during the Holocene has been well investigated in various records. However, whether such variability exists in older

interglacial periods remains elusive, hindering our understanding of climate variability on these short time scales and thus diluting the capability to project future climate change in a warming world. Here, we present a precipitation $\delta^{18}O$ record from ~124.73–121.57 ka BP, inferred from a stalagmite with clear annual lamination from Qiongguo Cave, southwestern Tibetan Plateau. The $\delta^{18}O$ values of stalagmites are rather negative and vary from -17.8‰ to -22.9‰, consistent with the fluctuation range and trend of $\delta^{18}O$ values of stalagmites in Tianmen Cave in the south-central Tibetan Plateau, indicating that water vapor conveyed by the Indian summer monsoon can still reach the southwestern Tibetan Plateau during this period. Modern observations show that precipitation $\delta^{18}O$ in regions (seasons at the study site) affected by westerlies is positively correlated with temperature, while precipitation $\delta^{18}O$ in regions (seasons) influenced by the Indian summer monsoon is inversely correlated with temperature and monsoonal water vapor transport, implying that the precipitation $\delta^{18}O$ fluctuations recorded by the Qiongguo stalagmite can reflect the interplay of these two climate regimes. The long-term variation of stalagmite $\delta^{18}O$ record closely tracks the 65°N solar insolation changes, confirming the dominant control of solar insolation on the Indian summer monsoon. EEMD, spectral, and wavelet analyses reveal multi-decadal (~60-year) and centennial (~230-year, ~580-year, etc.) periodic variations. Unlike the ~60-year cycles, which persist throughout the whole record, the fluctuations at centennial scales are apparent only at the late portion of the record. The study affirms that the ~60-year periodic variation of the Indian summer monsoon observed in the Holocene also exists in the last interglacial, demonstrating that solar activity and the Atlantic Multidecadal Oscillation may be the main factors regulating the ~60-year variability of the Indian summer monsoon in the warming world.

Keywords: Last interglacial, Tibetan plateau, Annual laminae, AMO, Solar activity

【A0540】

Seasonal monsoon variations and collapse of Late Brone Age civilization in China

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While the decline of complex societies has been linked to natural climatic changes, the specific impacts of seasonal climate variability on resource management and society stability remain insufficiently underexplored. Here, we present micron-scale isotopic and geochemical analyses of an annually laminated stalagmite in northern China, offering detailed records of seasonal climate during Shang to Western Zhou dynasties (~1600-771 BCE) - pivotal periods in the origin and evolution of Chinese civilizations. The results reveal that the East Asian Summer Monsoon (EASM) dissipates from northern China for decades in the late Shang and late Western Zhou, coinciding with the global 2.8-ka event. We suggest that the consecutive multi-decadal occurrences of rare, unexpected extreme climatic events, marked by severe aridity and decreased precipitation predictability in both summer and winter season, significantly reduced the millet-based agricultural productivity, triggering conflict over essential resources and thus contributing to the collapse of these agrarian societies. Additionally, we propose that the climate-induced agricultural stress may have driven a significant shift in dietary from millet to wheat, highlighting the broader implications of climate variability on society resilience.

Keywords: Stalagmite, Precipitation seasonality, Micron-scale analyses, Early China, Societal transformations

【A0174】

Monsoon activity and paleoceanographic responses in the southwestern Andaman Sea since 1.45 Ma

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The Indian summer monsoon (ISM) is a crucial component of interhemispheric heat and moisture transport, importantly influences socio-economic activities in South Asia through complex ocean-atmosphere land interactions. Although highly significant, the long-term variability of the ISM and associated paleoenvironmental responses remain poorly understood. The different feedbacks of various monsoon indices to orbital forcing

changes underscore the necessity for further research. Modern oceanographic observations reveal a positive correlation between the salinity difference in the Andaman Sea and the Bay of Bengal (BoB) and southwest monsoon intensity. The productivity in the Andaman Sea is influenced not only by the regional water structure shaped by southwest monsoon activity but also by the nutrient-rich Southwest Monsoon Current from the Arabian Sea. Using planktonic foraminifera assemblage records from sediment samples at Site U1448 of the International Ocean Discovery Program (IODP) Expedition 353, we reconstructed paleosalinity and paleoproductivity changes in the Andaman Sea since 1.45 million years. Comparative analysis with Site U1446 in the northwestern BoB, allowed us to evaluate ISM evolution and its impact on regional paleoceanography. Before the mid-Pleistocene transition (MPT), paleoproductivity at Site U1448 was lower, whereas the paleosalinity difference between Site U1448 and Site U1446 was higher. This elevated salinity difference likely reflects a northward shift of the Intertropical Convergence Zone (ITCZ) rainfall belt, caused by a reduced interhemispheric thermal gradient resulting from lower obliquity, rather than strong monsoon activity. In the post-MPT period, paleosalinity difference between these sites increased, and productivity at Site U1448 rose, coinciding with the restoration of obliquity, global ice volume expanded, increasing the cross-equatorial pressure gradient between the hemispheres and re-strengthening ISM. Our spectral analysis indicate that ISM was primarily regulated by the obliquity and related heterodynes during the pre-MPT period, while the salinity gradient and productivity proxies show eccentricity and related extension cycle and precession cycles during the post-MPT period. This shift highlights a transition in the ISM's external forcing mechanisms from obliquity to precession cycles, and underscores the strong modulation of the ISM and the associated paleoceanographic environment by internal forcing of the Earth's system.

Keywords: Indian monsoon, Andaman Sea, Mid-Pleistocene transition, Planktic foraminifera, Quaternary

【A0426】

Influences of pre-aged terrigenous organic carbon on deep-sea ventilation reconstruction

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Abrupt warming shown by rapid atmospheric pCO_2 rise is suggested to be related to the resume of Southern Ocean ventilation during the last deglaciation, which is influenced by weak AMOC intensity in the poor-ventilated North Atlantic though circulation bipolar seesaw. However, palaeoceanographic reconstructions documenting changes in deep-ocean ventilation using ^{14}C dating, may bear multidimensional explanations, obfuscating the roles of ocean ventilation played on atmospheric CO_2 rise. For example, there is extremely old ventilation ages of intermediate (>5000 ^{14}C years) and deep water (>10000 ^{14}C years) in the high latitude North Atlantic during Heinrich Stadial 1 (HS1), indicating weak AMOC intensity, but this extremely old ventilation ages seem incredible. Here, we show that previously inferred poorly ventilated conditions in the North Atlantic were linked to enhanced pre-aged organic carbon (OC) input during HS1. The ^{14}C age of sedimentary OC was approximately 13,345 ± 692 years older than the coeval foraminifera in the central North Atlantic during HS1, which is coupled to a ventilation age of 5,169 ± 660 years. Old OC was mainly of terrigenous origin and exported to the North Atlantic by ice-rafting. Remineralization of old terrigenous OC in the ocean may have contributed to, at least in part, the anomalously old ventilation ages reported for the high-latitude North Atlantic during HS1.

Keywords: Deep-ocean ventilation, AMOC intensity, North Atlantic, Radiocarbon age

【A1043】

Ostracode $d^{18}O$ values from Kiritimati Island reconstruct central tropical Pacific climate over the past 1700 years

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Understanding the patterns and mechanisms responsible for long-term changes in the tropical Pacific climate is necessary as natural decade-to-century scale variability in the state of the tropical Pacific and the emergence of anthropogenic trends remain uncertain. Here we present two new central tropical Pacific stable isotope ostracode valve records from the main lagoon of Kiritimati, Republic of Kiribati. We hypothesize that higher $d^{18}O$ values result from increased cooling and evaporation of lagoon waters, whereas lower $d^{18}O$ values reflect warming and lagoon freshening from increased precipitation and runoff. Preliminary results indicate increasing $d^{18}O$ values from 250-1000 CE, a period of high variability in $d^{18}O$ preceding a hiatus from 12-1400 CE, and a decreasing trend in $d^{18}O$ from 1700 CE-present. The lagoon sedimentation hiatus coincides with Kiritimati lake hiatus and Washington Island salinity spike. This indicates a potential period of severe aridity ~1400CE, or other abrupt, regional event. These data indicate high potential for Kiritimati lagoon ostracode $d^{18}O$ values to provide a continuous record of past climate variability, offering a new and valuable perspective on low frequency fluctuations and recent trends in the tropical Pacific climate system.

Keywords: Paleoclimate, Ostracode, Tropical Pacific

【A0283】

AWI's contribution to PlioMIP3 with two generations of Earth System Models

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The Pliocene Model Intercomparison Project (PlioMIP) has been ongoing since 2012, with the Alfred Wegener Institute (AWI) as an active contributor. During PlioMIP2 in 2020, AWI provided a substantial simulation ensemble using the Earth System Model COSMOS with

dynamic vegetation. Since then, our institute has developed two new multi-resolution models: AWI-ESM2 and AWI-CM3. For the current third iteration of PlioMIP, we are employing both models to simulate the Late Pliocene and Early Pliocene climates according to the new simulation design proposed for PlioMIP3. Although AWI-ESM2 and AWI-CM3 use different atmospheric models, they share the same ocean model. This setup not only allows us to contribute our own "mini-MIP" with AWI-affiliated models—exploring how the Earth System responds to varying boundary conditions and model parameters—but also offers a unique opportunity to understand better the impact of differences in atmospheric model characteristics on simulated Pliocene climate. Specifically, AWI-CM3 uses the OpenIFS atmospheric model (cycle 43r3v2), shared with the EC-Earth community, while AWI-ESM2 employs ECHAM6, versions of which have been part of the Max Planck Institute for Meteorology model family, including ECHAM5 in COSMOS and ECHAM6 in MPI-ESM. Both models incorporate the ocean model FESOM2. For PlioMIP3-compliant simulations, we maintain an atmospheric resolution of approximately 200 km in ECHAM6 and 100 km in OpenIFS. To simulate ocean dynamics, we use CORE2-grade resolution ocean meshes (nominal 1° resolution) with high spatial refinement to better resolve high-latitude and coastal dynamics. Both climate models include modifications in their paleogeography and initial conditions to accurately represent the Pliocene environment. Our models have already been used for PMIP4/CMIP6-compliant simulations, including piControl, abrupt-4xCO2, historical, midHolocene, and lig127k across various resolutions. The results are generally consistent with the CMIP6 ensemble in most climate performance metrics. To support PlioMIP3's model intercomparison effort, we plan to contribute core simulations LP and PI, as well as optional and legacy simulations: EP, LP280, LP560, PI400, PI560, LP_pi-orog, LP_lp-orog, LP_pi-ice, PI_lp-ice, and LP_pi-EAIS. These will be completed over 2025 and potentially into 2026. Here, we present an initial overview of the findings derived from AWI's contribution to PlioMIP3 using AWI-ESM2 and AWI-CM3.

Keywords: Pliocene Epoch, Past warm climates, Earth System Modelling, PlioMIP3, PMIP4/CMIP6

【A0364】

First discovery of the Laacher See Tephra in the Eastern Alps: Necessity for reassessing fallout patterns

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We report the pioneering identification of the Laacher See Tephra (LST) in the Eastern Alps, specifically in Lake Plansee, Tyrol, Austria. Using a comprehensive core-scanning workflow (magnetic susceptibility, computed tomography, XRF, µXRF, and electron probe microanalysis), we identified the LST despite the near-total dissolution of volcanic glass in alkaline lake sediments, by focusing on both the volcanic minerals associated with the eruption and the remaining geochemical signatures. This approach highlights the critical need to extend detection strategies beyond glass shards, particularly in cases of significant alteration and minute amounts of tephra glass shards.

The discovery of LST within the internal region of the Eastern Alps challenges existing assumptions about the LST's distribution patterns, suggesting a broader fallout area than previously recognized. It underscores the need for comprehensive tephrochronological investigations, particularly in regions beyond traditionally accepted fallout zones. This finding not only advances chronological frameworks and paleoenvironmental reconstructions but also the assessment of eruption impacts on past ecosystems, including human communities, and potential implications for future volcanic events.

Our methodology’s sensitivity in detecting trace amounts of cryptotephra and associated minerals opens new avenues for understanding tephra fallout dynamics and distribution. The identification of the LST in Lake Plansee highlights the potential for similar discoveries in other previously overlooked regions, including environments like alkaline lakes.

Keywords: Laacher See tephra, Tephra fallout, Distribution maps, Cryptotephra, Tephra identification

【A0241】

Asian monsoon orbital variability directly paced by CO_2 and precession, not eccentricity

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The Asian monsoon system supports over 3 billion people in East and South Asia today. It is therefore imperative to understand the factors that control the monsoon. In particular, geological data have widely recorded changes in monsoon intensity at orbital time-scale (~20,000, ~41,000, and ~100,000 year cycles), suggesting that insolation variations, coupled with greenhouse gas variations and ice sheet changes strongly control the monsoon system. However, it is unclear whether the monsoon intensity changes are directly controlled by insolation and what are the impacts of greenhouses gases and ice sheets.

Here we use a recently updated version of HadCM3B paleoclimate model with realistic boundary conditions to explore the orbital timescale drivers of Asian monsoon variations through the last 800,000 years. Three sets of 219 snapshot simulations were performed to simulate the last 800,000 years at 4000 year frequency (1000 year from 21kyr to present). The three sets differ by their orbital timescale forcings: one with changing insolation only, one with changing insolation and greenhouse gas variations only and the last one combining variations of insolation, greenhouse gas and ice sheet.

Our results show the strong influence of precession at ~21000 year period. However, at eccentricity timescales (~100kyr) the direct solar insolation impact is relatively small. Instead, we find that changes in greenhouse gases lead to a strong 100kyr response. Ice sheets do not impact directly the Asian monsoon's pace but its amplitude. This motivates further investigations considering separately what is impacting the pace or the amplitude

of Asian monsoon variations at orbital timescale to untangle its tangled drivers and has important implications for older time periods, and the future.

Keywords: Asian monsoon, Orbital-scale variations, Snapshot simulations, HadCM3B, Sensitivity study

【A0595】

Multiproxy reconstructions for bottom water oxygenation dynamics in the Gulf of Cadiz during the Early to Middle Pleistocene Transition (EMPT)

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The Early to Middle Pleistocene Transition (EMPT, 1200-700 kyr) marked a change in how Earth's climate system responded to orbital forcing. Throughout the EMPT, the frequency of glacial-interglacial cycles shifted from ~ 41 kyr to ~100 kyr, which resulted in more intense and longer-lasting interglacial periods. While the EMPT has been studied worldwide, the impacts of those changes in the Gulf of Cadiz, a transition zone between the Mediterranean Sea and the Atlantic Ocean, are still mostly unknown. High-resolution records from the Gulf of Cadiz, provide insights into variations in bottom water conditions during this interval. By analyzing the sediment sequence from IODP Site U1387 (559m water depth), which is currently influenced by Mediterranean Outflow Water (MOW), we reconstructed bottom water oxygen conditions from Marine Isotope Stage (MIS) 32 to MIS 19 (1100-761 kyr). In this study, we provide reconstruction of relative oxygen

concentration changes, based on benthic foraminifera assemblage data, carbon isotope gradients between epifaunal and deep-infaunal benthic foraminifera species, and U/Mn ratios in authigenic coatings of planktonic foraminifera. Our results indicate that periods of reduced bottom water ventilation along with reduced MOW flow strength during interglacial intervals are marked by decreases in oxygen levels, as reflected in all the proxy records. This signal is fully decoupled from the strong interglacial Atlantic Meridional Overturning Circulation and associated well-oxygenated North Atlantic waters. The decrease in diversity during low-oxygen intervals further supports the interpretation of stressing environmental conditions and highlights the impact of reduced MOW flow. The lower diversity might also reflect an increase in food supply, which favors specific benthic foraminifera species adapted to nutrient-rich, low-oxygen environments. Conversely, periods of higher oxygen levels are characterized by more diverse fauna, consistent with U/Mn ratios that indicate lower oxygen fluctuation and reduced environmental stress. This pattern highlights the impact of oxygenation and nutrient availability on benthic foraminiferal communities. Therefore, we hypothesize that longer periods of low oxygen levels as recorded by both geochemical proxies are likely attributed to reduced ventilation of the MOW in consequence of sapropel formation in the eastern Mediterranean Sea and increased rainfall and river run-off in southern Iberia. Short episodes of low oxygen levels, indicated by the carbon isotope gradient but not reflected in the U/Mn data, could be related to increased surface productivity. This scenario is exemplified during MIS 25, when seasonal upwelling is indicated by *Chaetoceros* spores. Our multiproxy approach for reconstructing past oxygenation provides a more robust interpretation compared to relying on a single proxy. Incorporating diversity indices and assemblage data further allows distinguishing between signals of productivity and low-oxygen conditions.

Keywords: Early to Middle Pleistocene Transition, Gulf of Cadiz, Benthic foraminifera, Mediterranean outflow water, Bottom water oxygenation

【A0603】

Last millennium changes in Mississippi River Basin hydroclimate as a framework for understanding future anthropogenic impacts

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Human activities, such as river engineering and land use changes, have altered the natural course of the Mississippi River, leaving the lower basin particularly vulnerable to future hydroclimate extremes. Extreme wet and dry events are expected to intensify in the 21st century as anthropogenic forcing compounds natural variations in seasonal circulation patterns. In particular, the strength and positioning of the Bermuda high and Great Plains low-level jet (GPLLJ) have important controls on moisture transport into the Mississippi River basin (MRB). However, considerable uncertainty remains about how these atmospheric dynamics will evolve over time and affect future MRB discharge. This uncertainty poses significant challenges for policymakers managing water resources, mitigating flood risks, and ensuring agricultural sustainability. To provide more robust constraints on future MRB hydroclimate, this study capitalizes on Community Earth System Model (CESM) ensembles (which explicitly include river routing) to determine the relative importance of greenhouse gases, land use changes, and atmospheric dynamics on hydroclimate extremes in the past, present, and future. The CESM1.2 Last Millennium Ensemble resolves long-term (multi-decadal to centennial-scale) controls on MRB hydroclimate, broadly extending the statistics afforded by observational data, while the CESM2 Large Ensemble offers improved streamflow estimates and a large ensemble with SSP3-7.0 forcing. Using previously-established indices for the Bermuda high and GPLLJ, we evaluate the changes in these large-scale atmospheric systems over the last millennium and 21st century. Our work indicates that a westward shift in the western flank of the Bermuda high and a stronger GPLLJ yields drier conditions in the lower MRB in the 20th and 21st centuries compared to the pre-industrial era. Although the MRB is generally projected to shift toward drier conditions in the 21st century, we find that the basin is wetter in the 20th century compared to the pre-industrial era, with land use changes driving elevated precipitation and soil moisture (Murphy et al., 2024, Paleo2). By clarifying the historical and future roles of atmospheric dynamics and land use changes in the MRB, these results provide actionable insights for policy and planning. Improved understanding of hydroclimate variability can inform regional water resource management strategies to balance competing demands between agriculture, industry, and municipalities. Insights

into the frequency and magnitude of past floods can support infrastructure design to reduce vulnerability to high-risk areas and inform crop diversification strategies. Given the myriad of factors contributing to future changes in the MRB, this work provides a foundation for building resilience in the 4th largest watershed in the world, preparing communities and ecosystems for an uncertain future.

Keywords: Hydroclimate, Land use change

【A0467】

Climate of the last 2500 years in the central Andes of Peru based on peatland deposition

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The high central Andes have experienced significant hydroclimatic changes in recent decades, impacting ecosystems through glacier retreat, temperature variations, and altered precipitation seasonality. Andean peatlands are crucial to water and biogeochemical cycles and are sensitive to climate change. To infer past climatic and environmental conditions, we analysed X-ray fluorescence (XRF) core scanning data, principal component analysis (PCA) with clr-transformation, and total organic carbon (TOC) on the APA01 peat core (basal age ~2500 years). PCA-clr explained 88.8% of variance, revealing interactions between organic matter (OM) content, accumulation dynamics, and climatic influences. The correlation between Log [S/Ti] and PC1-clr highlighted the interplay of OM concentration and erosion intensity. Environmental proxies such as Ln [Si/S] and Ln [Zr/Ti] ratios provided insights into accumulation processes and climatic impacts. Analysis of carbon accumulation rates (CAR) and mineral

accumulation rates (MAR) from 507 BCE to 1565 CE indicated distinct phases of organic and mineral accumulation, reflecting climatic changes.

Comparative analysis with regional climate records (Quelccaya and Illimani ice cores, Pumacocha Lake sediments) during the Medieval Climate Anomaly (MCA) and Little Ice Age (LIA) demonstrated broader climatic influences on peatland dynamics. Decreased OM accumulation during the MCA was linked to drier conditions, while increased accumulation during the LIA corresponded to wetter climates. Warming phases such as the MCA, post-LIA, and recent decades showed high clastic mineral input without necessarily wetter conditions, likely due to glacier and permafrost melting and increased snow-to-rain proportion.

Our data indicate a decline in peatland growth and OM accumulation since 2010, emphasizing the need for careful monitoring and future restoration efforts.

Keywords: Andes, Peatland dynamics, Climate change, XRF core scan, Carbon accumulation rate

【A0431】

Millennial-scale variability of the Asian summer monsoon over the last 690,000 years: Insights from cave records

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The Asian summer monsoon (ASM) is an important component of the global climate system. While the millennial-scale climate variability (MCV) of ASM have been well characterized by cave oxygen-isotope ($\delta^{18}O$) records over the last 640 ka, particularly for the last 60 ka, little information from cave records is available on ASM variability beyond U-Th dating limit of ~640 ka. On the other hand, whether the millennial-scale ASM variability recorded by various climate archives are consistent remains unclear, particularly in the context of the paradox observed from the different ASM orbital-scale records. Here, we present high-resolution and absolutely U-Pb dated cave $\delta^{18}O$ records from two Chinese caves, spanning 690–600 ka BP. Our records between 690–640 ka BP substantiate a coupling relation of millennial-scale weak ASM events with North Atlantic cooling and Antarctic warming, mirroring the pattern observed in the last 640 ka, despite of the potential shift of Atlantic Meridional Overturning Circulation (AMOC) inferred by changes in source of ice rafted debris in the North Atlantic. MCV amplitude comparisons among different ASM proxies show remarkable disparities, suggesting that each record reflects merely a certain aspect of ASM. In our records, summer insolation declines always triggered millennial weak ASM events near the midway at the precession band, responding to the AMOC weakening, which do not take place only at the end of interglacials. Additionally, our analysis suggests that both CO_2 level and global ice volume conditions remain critical factors between ~688–635 ka BP, influencing the ASM millennial variability.

Keywords: Speleothem, U-Pb dating, Asian summer monsoon, Millennial events

【A0161】

Millennial-scale impacts of climate and land use on fynbos vegetation in the Cape Floristic region, South Africa

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Climate change projections continue to raise concerns over ecosystem vulnerability and global biodiversity loss. Mediterranean-type ecosystems (MTEs) are also anticipated to be especially sensitive to change due to altering fire regimes, variations in plant available moisture, and invasive species which can impact ecosystem services. Jonkershoek (JNK), a biodiversity hotspot and an MTE in the Cape Floristic Region of South Africa has a decadal history of ecological monitoring without centennial and millennial-scale records of land use to conceptualize change. This study applied multiple paleoecological proxies including pollen, dung spores, charcoal and geochemistry to investigate 5400 years of different land use and climate regimes, and their impact on the fynbos vegetation.

The results suggest an incredible resilience within the fynbos biome through time. During the mid-Holocene, under cooler conditions and San hunter-gatherer occupation characterized by moderate fire regimes, restioid fynbos dominated the slopes. By the late Holocene, this transitioned to grassier fynbos associated with variable climates and reduced fire activity. Subsequently, under the cooler conditions in the Little Ice Age, the intensified anthropogenic activities from European settlers brought about indiscriminate fires, soil disturbances, and the proliferation of invasive alien plants (IAPs). Despite these pressures, the resurgence of Restionaceae highlights the fynbos biome's capacity for resilience and recovery

An understanding of the trajectory of recent changes in MTEs for designing effective restoration strategies requires long-term monitoring and historical knowledge that predates the more recent intensive human impact. For instance, fire regimes in the recent 400 years are atypical when compared with the longer-term history of the site. This can be linked to anthropogenic influence and fuel load increase from invasive taxa. While ecological thresholds may not have been crossed presently at the biome level, proactive management is essential to mitigate fire frequencies and reduce biomass to preserve ecosystem integrity, especially under future climate scenarios. This study emphasizes the critical role of palaeoecological in providing information for future management of vegetation and fires, offering a vital complement to decadal-scale monitoring efforts for sustainable ecosystem management.

Keywords: Paleoecology, Fynbos, Fire regimes, Land management, Mediterranean ecosystems

【A0598】

Modelling Antarctic margin response to Pleistocene like warming

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The Antarctic ice sheet is potentially the largest but most uncertain component of sea level rise under anthropogenic warming. With the twelve months to January 2024 the first to average > 1.5℃ warming above pre-industrial, determining how the ice sheet responds to prolonged moderate warming is key to understanding sea level change and coastal impacts in the coming decades to centuries. Warm Pleistocene interglacials, 1-2 ℃ above pre-industrial, are a natural analogue for Antarctica under moderate warming. However, where and how much Antarctica retreated during these periods remains uncertain. Determining whether collapse mechanisms were triggered under moderate Pleistocene warming, and in which regions, is key to improved projections of how the ice sheet will respond to ongoing and future warming.

The GEO-ICE project aims to improve our understanding of Pleistocene glacial-interglacial Antarctic retreat dynamics, by combining numerical ice sheet models with sediment core data – including new cores from the Ross Sea. We present new simulations that explore Antarctic retreat under late Pleistocene interglacial warming. Using physically comprehensive ice sheet model experiments, we simulate Pleistocene Antarctica under idealized forcing scenarios. These experiments resolve key grounding line and ice stream processes, and capture how these respond to Pleistocene-like ocean and atmosphere forcing. We combine novel ice-proximal geochemical proxy records and ice sheet model outputs, to constrain uncertain model processes and improve our modelling framework. This allows us to explore how the Antarctic ice sheet responds to moderate Pleistocene-like warming, which can inform predictions of the ice sheets near-future.

Keywords: Northwestern China, Tree-ring oxygen, Wetting trend, Natural variability

【A0883】

A global high-resolution modeling of the Mid-Holocene climate

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The Mid-Holocene (MH; 6 ka) is a key period for studying past climate changes, providing insights into the interactions between insolation, monsoon systems, and ecosystems under natural forcings, primarily driven by orbital changes. Thus, the MH experiment has been one of the standard experiments since the first phase of the Paleoclimate Modelling Intercomparison Project (PMIP). However, most simulations were carried out using low resolutions, typically with a horizontal resolution of ~2° for the atmosphere, limiting their ability to capture fine-scale processes. Here we conduct a series of high-resolution (~0.25°) MH experiments using CAM4, to investigate the influence of orbital changes, Sahara greening, vegetation expansion, and reduced dust emissions on the MH climate. These experiments allow us to explore not only the changes of precipitation and surface temperature in greater detail, but also those of the tropical cyclone (TC).

Results from the high-resolution simulations show a much larger change in the annual mean precipitation over most regions between MH and pre-industrial (PI) compared to the low-resolution results; the responses of summer monsoon to insolation change are thus much stronger too. Compared to low-resolution simulations, the high-resolution experiments also show larger increase in surface temperature over mid- to high-latitude lands. Additionally, the results show that the greening of Sahara causes a great reduction in TC activity over North Atlantic. Our study highlights the critical importance of high-resolution modeling in capturing global and regional climate dynamics and extreme weather events.

Keywords: Mid-Holocene, High-resolution modeling, Climate, Tropical Cyclone

【A0423】

Indian monsoon driven N_2O emission in the Arabian Sea during the last two interglacial cycles

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Under a 2˚C future warming scenario, calculating the total Carbon budget becomes imperative. In this context, estimating other greenhouse gases, such as nitrous oxide (N_2O), is crucial. This study aims to delineate the long-term variability of atmospheric N_2O. Modern estimates suggest that oceans contribute nearly 40% of natural N_2O emissions to the atmosphere, primarily through denitrification in oxygen-deficient waters. The Arabian Sea, with its intense Oxygen Minimum Zone (OMZ), accounts for almost one-third of these emissions. The strength of the OMZ is controlled by enhanced primary productivity during the strong monsoon seasons, leading to higher denitrification and increased N_2O production. To understand the role of the Arabian Sea denitrification in N_2O dynamics, we analyzed the relative abundance of planktic foraminifera *G. bulloides*, total nitrogen, and $\delta^{15}N$ of the bulk sediments from the marine sedimentary core SSD004 GC11 (6.0000°N, 78.9312°E; 2901 m), spanning last 175 kyr BP. Our $\delta^{15}N$ record shows strong covariance with *G. bulloides* values, closely resembling atmospheric N_2O observed in ice core records. Higher $\delta^{15}N$ and *G. bulloides* during interglacials indicate higher denitrification linked to increased productivity and higher atmospheric N_2O levels, while lower values during glacials suggest the opposite.

We compiled published $\delta^{15}N$ records from across the Arabian Sea, revealing synchronous denitrification fluctuations regionally. However, the magnitude of these variations differed, influenced by the spatial distribution of the OMZ core and changes in subsurface ventilation on glacial-interglacial timescales. This study highlights the Indian Monsoon's role in driving Arabian Sea denitrification and its contribution to atmospheric N_2O levels.

Keywords: Denitrification, Arabian Sea, Indian summer monsoon, Nitrous oxide

【A0496】

Holocene vegetation history of western Chukotka inferred from pollen records

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Although paleoenvironmental studies in high Arctic intensified in last decades, many regions of the northeastern Siberia are still not covered by paleoecological studies. In our work we present 5 new Holocene pollen records from northwestern Chukotka. Study sites are located in the basin of Yurumkuveem River (2 sections), Chaun Lowland (2 sections) and lower flow of Pegtymel River (1 section). The studied sites differ in their climate, vegetation and distance from the seashore.

Sections Nyrki and Kuiviviem (Yurumkuveem basin) are covering the Early to the Mid- and Late Holocene respectively. In the Early Holocene (prior to 8.7 cal ka yr BP) climate of the area was warmer as reflected by the presence of larch, chosenia and poplar in the local vegetation, which are absent in the area nowadays. These taxa gradually disappeared from local vegetation during the Mid Holocene. The modern-like vegetation was established in the area after 5 cal ka yr BP. Pollen records from Chaun Lowland (sections D-21-1 and P-21-2) suggest that first half of the Holocene was characterized by warm climate, compare to the last 5 thousand years. Between 12.2 and 7.2 it possible to distinguish some climate fluctuations, including a short period of cold and dry climate. However, it's hard to assign a precise chronological borders for them, due to the lack of radiocarbon dates. After 5.2 ka yr BP climate have started to slowly deteriorate, which

was expressed in movement of the dwarf alder stands to the south, further from the sea shore. It's hard to build a strong chronology for Lower Pegtymel (section P-5) due to the multiple inversions of radiocarbon dates, but we can conclude, that the most favorable conditions during the sediment accumulation occurred in the region during the Late Glacial and the Holocene transition, when shrub alder grew in the nowaday shrubless area. After the Holocene onset climate started to get colder and herb communites with limited presence of dwarf birches start to dominated local vegetation.

We can state some time lag in the establishment of optimum conditions in northwestern Chukotka: the earliest optimum was recorded in the Lower Pegtymel' study area, while in the Yurumkuveem River basin the warmest climate conditions are recorded prior to 8.7 ka yr BP, and in the Chaun Lowland area - first half of the Holocene.
Macroremains of tree birches, collected in numerous locations from Chaun Lowland, usually have age between 11 and 9 ka yr BP, contradicting obtained pollen data. This disagreement could be caused by several reasons including redeposition of organic material during section accumulation, used as a dating material or hiatus in the sediment record.

Further studies of Quaternary sediments of the region, as well as usage of different proxies will help us to build a more objective picture of Late Quaternary paleoenvironmental dynamics.

Keywords: Paleoclimate, Landscape evolution, Geochronology

【A0027】

Extreme drought around 900 ka in Southwestern Iberia: Insights from IODP pollen records

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The Middle Pleistocene Transition (MPT) marks a key period in Quaternary evolution, with a shift in glacial-interglacial cycles from ~40 kyrs to ~100 kyrs, increased global ice volume, land aridity, and lower sea surface temperatures. While the driving mechanisms of the MPT remain unclear, the most likely hypotheses are related to ice-sheet dynamic feedbacks, such as ice albedo, precipitation at ice margins, elevation-temperature, the regoliths, and the decrease of CO_2 concentration. Here we focus on the "precipitation at the ice margins" hypothesis. To test this hypothesis, appropriate proxy reconstructions and paleoclimate simulations are needed.

The Southwestern Iberian margin is directly influenced by the westerlies, which play a crucial role in delivering moisture to the Northern Hemisphere ice sheets. Here we present new pollen records from the International Ocean Discovery Program (IODP) Sites U1386 and U1385, capturing vegetation dynamics and winter rainfall fluctuations in Southwestern Iberia during the MPT. Our results reveal a long-term decline in Mediterranean Forest (MF) coverage during MIS 31-22 (1200-870 ka), closely aligned with the gradual reduction in boreal summer insolation at 65°N. This trend culminated in a period of extreme aridity between 930 and 870 ka. This period of strongest dryness coincides with the highest North Atlantic Ice Rafted Debris (IRD) concentration, weakest Atlantic Meridional Overturning Circulation (AMOC) and highest dust input from north Africa to the Mediterranean Sea during MIS 24-22, and coeval with the southward migration of the thermocline water source, related to the position of the moisture source, lower than the Iberian margin. After 870 ka, the trend was reversed and the MF thrived again during MIS 21, associated with the increase in insolation and AMOC and the

northward shift of the moisture affecting Iberia. During MIS 20, the strong reduction of the MF during this glacial reflects the second extreme regional drought, probably due to the maximum ice volume, supported by the heaviest benthic foraminifer $\delta^{18}O$ ($\delta^{18}O_b$) values, and the southernmost position of thermocline water source at around 830 ka. From MIS 19 to MIS 18, the insolation remained low, but the MF increase concomitant with the northward migration of the moisture source that bring precipitation to Iberia through the Westerlies. The increase in insolation, the decrease in ice volume and the optimal position of the moisture source close to Iberia, led the maximum expansion of the MF during MIS 17. A pronounced contraction of the MF after 700 ka suggests the north shift of the westerlies, leading to the strong 100-kyr cycles. Furthermore, the wavelet analysis on the MF, $\delta^{13}C$ and $\delta^{18}O_b$ records has showed the dominant cyclicity is in the 80-kyr band between 1200 ka to 1050 ka, and faded away from 1050 ka to 840 ka including the mega drought period. After 840 ka, the obliquity and precession cyclicities emerged, and even the 5.5-kyr cyclicity can be found in the MF. Our data suggest the strong IRD-derived freshwater fluxes blurred the predictable North Atlantic orbital climate cyclicity during 930-840 ka.

Keywords: The Middle Pleistocene Transition, Mediterranean Forest, Extreme drought, Moisture source, Iberian margin

【A0254】

Using multi-proxy to reconstruct the vegetation in northwestern Madagascar throughout the mid-Holocene and its relevance to biodiversity conservation

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The most threatened ecosystem in Madagascar is the western dry tropical forest. Human activities have significantly impacted the loss of vegetation cover and erosion, particularly in sedimentary areas and regions with prolonged dry seasons, such as the northwest

region. These assumptions have led to policies of general tree planting to restore degraded land and combat soil erosion. However, the vegetation dynamic and the interactions between human and climatic drivers over time are still unclear and debated. This study uses fossil pollen and stable carbon isotopes (C) from two sediment cores from northwestern Madagascar dated ca. 5400 cal years BP and six decades, respectively, to understand the vegetation dynamics. Major and trace elements (MTE) such as Si, K, Ti, Fe/K ratio, and Sr/Ca ratio, as well as charcoal and spores, help explain the signs of climate change, fire, and herbivory activity.

The findings highlighted that bushland, wooded savanna, and grassland have been categorized as open vegetation and have existed in the northwest region even before the human settlement (ca. 2000 BP). During this period, the values of $\delta^{13}C$, fire records, and herbivory activity were low. From ca. 2000 years PB, we detected a past erosion signal through an increase in Si and K values which correlated with the increase of fire records and herbivory activity. Between 2000 and 1000 cal BP, $\delta^{13}C$ values declined at the same time as Fe/K and Sr/Ca ratios. This showed that the hydroclimate variability was low and was linked to a drought period. Human activity has impacted the vegetation cover, which had increased from 1000 cal BP during a drier climate with low Fe/K and Sr/Ca ratios. Human settlement has intensified this impact, leading to erosion, particularly in the last six decades. Those findings can be used for conservation management of the dry ecosystem in the western region of Madagascar and across Africa, with a particular focus on erosion prevention, reforestation, and climate change.

Keywords: Mid-Holocene, Dry forest, Pollen, Geochemical, Conservation

【A0040】

Oscillations in mid- to late Holocene environments of the lower Negro River, central Amazonia, recorded in pollen and diatom from Lake Pacú sediments

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The mid- to late Holocene transition in the lower Negro River reveals significant insights into the ecological succession and climatic history of central Amazonia. Analyzing sedimentary, pollen and diatom data, this study presents an uninterrupted regional view of the ecological and environmental variations from the largest lake in the lower Negro River. Microfossil findings indicated dominance of igapó forests throughout the analyzed timespan. The sedimentary record suggests that at ca. 5020 cal yr BP, there was a transition from a high-energy "open-fluvial" environment characterized by sand deposition to a low-energy setting, allowing the sedimentation of fine-grained sediments. From ca. 5020 to 1600 cal yr BP, the area witnessed multiple alternations between pioneer (periphytic diatoms and herbaceous plants) and climax species (planktonic diatoms and floodplain forests). The synchronized fluctuations in the terrestrial and aquatic ecosystems suggest significant hydrological variations in central Amazonia during the mid- to late Holocene. After 1600 cal yr BP, the record is marked by the dominance of floodplain forests and planktonic diatoms, resembling a modern igapó forest climax state. Our record underscores the interdependence of aquatic and terrestrial ecosystems in this area. Overall, it depicts a dynamic scenario in the lower Negro River, with water level fluctuations exerting a major control on ecological succession

Keywords: Negro river, Ecological succession, Holocene, Pollen, Diatom

【A0523】

Precise timing, duration and impact of 4.2 ka event on monsoon seasonality and productivity in the southwestern Bay of Bengal

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The Indian subcontinent has a long history predominantly shaped by the monsoon system, a critical climatic phenomenon that governs regional agricultural practices and ecosystems. The Indian monsoon is marked by a prominent shift termed as 4.2 ka event.

A weakening of the summer monsoon resulted in aridification and the subsequent collapse of many civilizations during the 4.2 ka event. However, little information is available about the onset, and duration of 4.2 ka event and its impact on monsoon seasonality, productivity and carbon burial in the western Bay of Bengal. Here, we present a decadal resolution marine sediment-based record of the precise onset, duration, carbon burial, monsoon seasonality and productivity changes in the western Bay of Bengal during the 4.2 ka event, by using the planktic foraminiferal and sediment characteristics. We report an abrupt decrease in carbon burial beginning at 4.65 ka and continuing till 4.1 ka. The summer monsoon was weaker and winter monsoon was relatively stronger during this interval. The synchronous decrease in coarse fraction (>63 µm), $CaCO_3$, C_{org} and nitrogen (N) suggests a collapse in productivity. The increase in C_{org}/N at the onset of the event suggests an increase in terrestrial input due to a stronger winter monsoon. Therefore, it is clear that the changes during the 4.2 ka event lasted for ~550 years and resulted in a significant decrease in carbon burial in response to weaker summer monsoon and relatively stronger winter monsoon in the southwestern Bay of Bengal. The Indian subcontinent has a long history predominantly shaped by the monsoon system, a critical climatic phenomenon that governs regional agricultural practices and ecosystems. The Indian monsoon is marked by a prominent shift termed as 4.2 ka event. A weakening of the summer monsoon resulted in aridification and the subsequent collapse of many civilizations during the 4.2 ka event. However, little information is available about the onset, and duration of 4.2 ka event and its impact on monsoon seasonality, productivity and carbon burial in the western Bay of Bengal. Here, we present a decadal resolution marine sediment-based record of the precise onset, duration, carbon burial, monsoon seasonality and productivity changes in the western Bay of Bengal during the 4.2 ka event, by using the planktic foraminiferal and sediment characteristics. We report an abrupt decrease in carbon burial beginning at 4.65 ka and continuing till 4.1 ka. The summer monsoon was weaker and winter monsoon was relatively stronger during this interval. The synchronous decrease in coarse fraction (>63 µm), $CaCO_3$, C_{org} and nitrogen (N) suggests a collapse in productivity. The increase in C_{org}/N at the onset of the event suggests an increase in terrestrial input due to a stronger winter monsoon. Therefore, it is clear that the changes during the 4.2 ka event lasted for ~550 years and resulted in a significant decrease in carbon burial in response to weaker summer monsoon and relatively stronger winter monsoon in the southwestern Bay of Bengal.

Keywords: 4.2 ka event, Monsoon, Civilizations, Planktic foraminifera, Bay of Bengal

【A0218】

Pollution history and anthropogenic-induced increase in the transport of toxic metals from Australia to Sub-Antarctic islands

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Mercury (Hg), is a volatile toxic metal, with a large atmospheric emission and transport capacity. The biogeochemical cycle of Hg is sensitive to changes in climate, yet our understanding of the impact of climatic factors on the Hg cycle remains limited. A primary challenge in Hg research involves distinguishing alterations in Hg levels resulting from human activities from those driven by climatic variations. This research focuses on examining how industrialisation and climate change have increased toxic metal pollution in the Australia-Pacific region, a distinctive and underexplored area where Hg deposition fluxes are often extrapolated from global models. Studies have found Hg in remote areas of Australia, the Southern Ocean, and Antarctica, with increased deposition occurring with the great acceleration. Here we use a multi-proxy framework to differentiate climatic events from anthropogenic factors in Southern Australia, and sub-Antarctic islands (Macquarie and Campbell) over the past 8,000 years. We aim to reconstruct and disentangle impacts of anthropogenic emissions, feral animals and those caused by climate change, such as the intensification of the southern hemisphere wind belt on the deposition of toxic metal pollution to understand the biogeochemical processes governing Hg behaviour in lacustrine ecosystems. Using a multi-proxy framework facilitates the precise quantification and interpretation of Hg deposition sources and accumulation rates in the context of a changing climate. This research will inform contamination amelioration strategies, and support Australia's efforts to meet its international obligations under the Minamata Convention on Mercury. This research is in collaboration with the Australian Nuclear Science and Technology Organization, the British Antarctic Survey, and the University of Tianjin, China.

Keywords: Mercury, Climate, Paleolimnology, Ecology

【A0601】

Impact of summer-persistent ENSO events on the global climate and the occurrence of extreme weather events

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The El Niño Southern Oscillation (ENSO), a leading driver of climate variability in the tropical Pacific Ocean, exerts considerable influence on global weather systems and ecosystems, affecting communities across the world. This study examines the underexplored phenomenon of summer-persistent ENSO events, exploring their worldwide climatic effects and their contribution to the occurrence of extreme weather events.

ENSO events are typically associated with a distinct cycle, with El Niño phases following this pattern more closely. In contrast, some La Niña events may fall below the ENSO threshold during the summer and then regain strength in the following winter, leading to multi-year La Niña events. However, there have been cases where ENSO events exhibit prolonged decay, with sea surface temperature (SST) anomalies remaining above the ENSO threshold well into the northern hemisphere summer. A notable example is the 2018/19 El Niño, which persisted until July and was associated with major events such as the 2020 Australian bushfires and the record-breaking North Pacific heatwave in 2019. This El Niño was succeeded by a triple-dip La Niña linked to severe weather impacts across Africa, Australia, and the United States. These examples underscore the critical need to study summer-persistent ENSO events and their global impacts.

This study is structured around three primary objectives: identifying past summer-persistent ENSO events, analyzing their effects on global temperature and precipitation patterns, and investigating their association with extreme weather events. Using the Oceanic Niño Index derived from the Extended Reconstructed Sea Surface Temperature dataset (ERSSTv.5), we classified ENSO events into conventional and summer-persistent ENSO events. The latter was defined by cases where the Oceanic Niño Index remained above the ENSO threshold through June of the decaying year. A total of 18 summer-persistent ENSO events were identified since 1895, divided into six summer-persistent El Niño and twelve summer-persistent La Niñas. To evaluate the climatic impacts, we utilised NOAA-CIRES-DOE 20th Century Reanalysis (NCEP 20CR) composites of 2-meter temperature and precipitation, comparing these ENSO types across both winter and summer seasons. The robustness of the composite analysis was assessed using AMIP ensemble simulations with dynamic atmospheric and vegetation components of EC-Earth Earth system model. This study enhances our understanding of summer-persistent ENSO events and their global climate effects, providing critical insights for mitigating their impacts on climate variability and extreme weather events.

Keywords: El Niño Southern Oscillation (ENSO), Climate variability, ENSO variability, Extreme weather

【A0179】

Identification of the Cretaceous-Paleogene boundary at northern Ninetyeast Ridge: Evidence from planktonic foraminiferal biostratigraphy and portable X-Ray fluorescence analysis

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During the latest Maastrichtian, an asteroid impact led to a massive influx of carbon dioxide into the atmosphere over a short period, causing global warming. The magnitude of the temperature increase during this event was comparable to the current trends in

global warming. Studying climate change during this period provides valuable insights into today's climate research. To conduct such studies, it is crucial to establish an accurate chronostratigraphic framework first. In this regard, Planktonic foraminifera are excellent tools for biostratigraphic research. However, due to the challenges in obtaining such age-old sediment samples from ocean drilling, research on the Cretaceous-Paleogene boundary in marine sediments is less developed than in terrestrial ones. Here we select samples from site U1443 of International Ocean Discovery Program (IODP) Expedition 353 at northern Ninetyeast Ridge for planktonic foraminiferal biostratigraphy research from late Cretaceous to early Paleogene. Incorporating portable X-ray fluorescence (XRF) data, the stratigraphic position of the Cretaceous-Paleogene boundary has been determined.

The biostratigraphic results show that the last occurrence of *Abathomphalus mayaroensis* was identified in sample U1443A-39X-4 W, 111-115 cm (287.56 m), determining the age at a core depth of 287.44 m to be 66.35 Ma. In sample U1443A-39X-4 W, 39-43 cm (286.84 m), the last occurrence of *Globotruncana* spp. (belonging to P0 fossil zone) was identified, indicating that the age at a core depth of 286.72 m is 66.04 Ma, which corresponds to the Cretaceous-Paleogene boundary. In sample U1443A-39X-3 W, 115.0-117.0 cm (286.27 m), the first occurrence of *Parvularugoglobigerina eugubina* (belonging to Pα fossil zone) was identified, indicating the age at a core depth of 286.44 m to be 66.00 Ma. Portable XRF results show that slightly below the Cretaceous-Paleogene boundary (about 287.00 m) determined by planktonic foraminifera biostratigraphy, concentrations of calcium, barium, potassium, sulfur, and strontium exhibited a marked decrease, while iron concentrations increased. This study provides a crucial foundation for future global stratigraphic correlations and paleoclimate research.

Keywords: Ninetyeast Ridge, Cretaceous-Paleogene boundary, Planktonic foraminifera biostratigraphy, Portable XRF

【A0777】

From past to present: Diversity trends of benthic foraminifera in the margin of NW South America

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Northwestern South America's Caribbean and Pacific margins are recognized as marine biodiversity hotspots. However, research has predominantly focused on coastal ecosystems, leaving deeper environments, such as the continental slope zone, understudied, particularly regarding microfaunal composition and diversity. Recent studies provide valuable insights into the distribution of benthic foraminifera along the current shelf and slope of the Caribbean and Pacific basins adjacent to Colombia. Based on this, we utilize quantitative data from Fiorini (2015) to calculate Shannon diversity indices (H') and incorporate the H' index reported by Patarroyo and Martínez (2021). We compare these with our new data on benthic foraminiferal diversity spanning the Cenozoic. Our analysis includes over 700 samples from 11 onshore wells in the Caribbean margin, covering a temporal range from the Paleocene to the Pleistocene, mostly when the Pacific and Caribbean were connected through the Central American Seaway (CAS).

On average, richness and H' values are 24.7 and 2.5 in the present Caribbean slope, respectively, while in Pacific environments, the values are higher at 40.3 and 2.9. Our Cenozoic dataset shows richness peaks during the early Miocene (25.5) and late Miocene (25.4) but declines to 4.3 in the Pliocene and 2.5 in the Paleocene. The H' index shows its highest values in the late Oligocene (3.15) and late Miocene (3.05), with its lowest in the Paleocene and Pliocene (0.66).

Peaks in benthic foraminiferal richness align with periods when major river systems flowing into the southern Caribbean Sea were active, delivering high loads of organic matter and nutrients that enhanced primary productivity. Conversely, the lowest richness values correspond to tectonically intense periods, such as the collision of the Caribbean oceanic plate with South America in the early Paleocene and the complete closure of the CAS in the Pliocene, which caused significant ecosystem stress. The highest diversities in the late Oligocene reflect periods of regional tectonic stability, mesotrophic conditions, and climatic cooling, which created environments conducive to maintaining high diversity.

Our results reveal that the current Pacific slope exhibits significantly higher richness than the Caribbean. However, present-day richness in the Caribbean is comparable to the highest levels observed during the Cenozoic. In terms of diversity, H' values for both the Pacific and Caribbean approach 3 are similar to the highest diversity levels recorded in the Cenozoic. These findings underscore the resilience of these ecosystems despite past tectonic and environmental upheavals.

This comparison identifies critical thresholds and shifts in diversity over geological time, providing insights into the ecological resilience of benthic communities under past climatic and environmental changes. These findings deepen our understanding of how biodiversity responds to long-term natural drivers, offering valuable lessons from the past for interpreting present-day ecosystems and laying the groundwork for future research to address current anthropogenic pressures.

References:

Fiorini, F., 2015. Recent benthic foraminifera from the Caribbean continental slope and shelf off west of Colombia. Journal Of South American Earth Sciences 60, 117 – 128.

Patarroyo, G.D., Martinez, J.I., 2021. Composition and diversity patterns of deep sea benthic foraminifera from the Panama basin, eastern equatorial Pacific. Deep-Sea Research Part I: Oceanographic Research 169, 103470.

Keywords: Benthic foraminifera, Cenozoic diversity, Caribbean and Pacific margins, Ecological resilience

【A0143】

Evaluation of sedimentary DNA as a Southern Ocean sea ice proxy

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Sedimentary ancient DNA (sedaDNA), i.e. DNA molecules originating from past organisms and preserved in sediment archives, is an emerging tool in marine paleoecology. It allows reconstructing entire biological communities, including lineages without a traditional fossil record. Thus, it can enable the reconstruction of past ecosystems to unprecedented detail not possible with microfossil proxies alone. In polar regions, sedaDNA has great potential to be used as a sea ice proxy by tracing sea ice associated species across time. Comparing the biodiversity captured by sedaDNA to traditional proxies such as those based on diatoms will provide a more complete picture of paleo-sea ice reconstructions.

A crucial step before we can reconstruct past sea ice conditions based on sedaDNA, is to calibrate this new proxy by documenting the links between modern sea ice conditions and marine biodiversity as preserved in recent sedimentary DNA. Here we present results from a DNA metabarcoding study that focuses on documenting marine biodiversity linked to sea ice coverage across the Weddell Sea and the Drake Passage in the Southern Ocean. Our surface sediment samples are from locations that in modern times are characterized by open ocean conditions, seasonal or permanent sea ice cover. We successfully extracted DNA from the sediment at >40 stations yielding total DNA concentrations of on average 6.6 ng/µL. We then amplified and sequenced the V9 region of the SSU rDNA targeting eukaryotes with promising results. On average, we obtained a sequencing depth of 500.000 reads per sample. First results indicate that communities at the coastal area around the Antarctic Peninsula with a high seasonal variance in sea ice coverage are dominated by diatoms. In the central Weddell Sea and the Drake Passage small flagellates and ciliates are more abundant.

Here, we link identified communities to the modern sea ice coverage, sea ice biomarkers, microfossil assemblages (diatom and dinoflagellate cyst) and sedimentology. In the future, the found associations between sea ice coverage and sedimentary DNA biodiversity will be used to reconstruct past sea ice conditions as documented in a sediment core in the north-western Weddell Sea.

Keywords: Seda DNA, Sea ice proxy, Southern Ocean, DNA

【A0434】

LA&ID-MC-ICPMS U-Pb dating of carbonate and its applications

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Carbonate U-Pb dating techniques have broad applications. Recently, the U-Pb Isotope Diluent (ID) and Laser Ablation (LA) dating of carbonate U-Pb have developed rapidly and many important advances have been made. Yet the U-Pb LA method has not been used to obtain ages of carbonate formed in the Quaternary, and the ID method for carbonate U-Pb dating remains unavailable in China. In this context, the U-Pb LA & ID MC-ICPMS dating techniques have been developed in the Isotope Laboratory of Xi'an Jiaotong University and applied to establish chronology for a set of speleothems across the Quaternary. We got the U-Pb ages of carbonate standard samples (WC-1, Duff Brown Tank, and Tarim) and speleothems by LA method. The results were consistent with the within the quoted uncertainties. We discussed the U-series initial disequilibrium corrections which is critical to the Quaternary samples and then highlighted the importance of ID methods for high-precision measurements of both $\delta^{234}U$ and Pb isotopes. The U-Pb results of late Quaternary samples (~500ka) after correction can be verified with the U-Th age. Regarding the U-Pb ID method, the total Pb blank in our lab could reach the world-class level (ca.10 pg). Our preliminary ID ages (e.g., 1.14 $\pm$0.04 Ma, 2σ, n =5, MSWD =1) obtained from Quaternary speleothem samples are in agreement with theprevious results from the U-Pb lab of Melbourne University, Australia. The age precisions are expected to improve with further work. In short, we have developed high-precision LA and ID U-Pb dating method in the Isotope Laboratory of Xi'an Jiaotong University. Which are applicable to date carbonate samples formed in time period older than ca. 500ka. This will effectively propel our scientific researches further back the deep-time beyond the U-Th dating range.

With the latest U-Pb dating methodology, we obtained a partial record of the Asian summer monsoon for the last 3.6 million years using speleothems, facilitating the study

of climate events, including MIS M2 and the MPT. In addition to "young" speleothems, we also tried older carbonates and even fossilized dinosaur eggs, and obtained results with relatively high precision.

Keywords: Monsoon, Paleoclimate, Geochronology

【A0048】

From fire to famines? The climate and human impacts of the 1831 and 1835 volcanic eruptions in India, China and Japan

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1831 and 1835. Multiple massive eruptions send vast plumes of sulphur into the atmosphere, forming a layer of aerosols that reaches around the globe. In the years that follow, terrible famine strikes countries across Asia: In China, the Imperial bureaucracy records drought and starvation in many eastern provinces; in Japan, hundreds of thousands die in the disastrous Tenpō famine; while in British India, famines in Madras and Agra lead to the reported deaths of over a million people. Just a coincidence? By combining historical accounts with the latest climate reanalysis data, we can begin to identify the contribution of volcanic activity to these famines. Taking India as our main case study, we will see how teleconnections between volcanic eruptions and Indian temperatures may have triggered significant monsoon failures in 1832/33 and 1836/37. But we will also see how the social impacts were intensified by many other climate and historical factors, ranging from the El Niño Southern Oscillation, to over-taxation and environmental decline, to the ideals of free market economics and the consequences of a joint-stock company with power over an entire subcontinent. In the case of Japan, work is still ongoing, but the initial results assessing the link between eruptions and the Tenpō famine will be presented. Meanwhile, in China we will see how droughts and famine often seem to follow major volcanic eruptions, but with impacts moderated by the El Niño/La Niña cycle. The talk will conclude by considering modern famines and climate change, and what lessons we can draw from such historical studies.

Keywords: Eruptions, Famine, Asia, Historical, 1830s

【A0561】

Unravelling abrupt transitions of Antarctic ice sheet dynamics during the mid-Pleistocene transition

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A mechanistic understanding of the main drivers of Quaternary climate variability, especially during the mid-Pleistocene transition (MPT; around 1.2–0.8 million years ago) remains a significant challenge in paleoclimate research. Climate changes during that time include a pronounced shift from 41-kyr to 100-kyr periodicity of glacial cycles as imprinted on sea level reconstructions, and the emergence of much larger ice sheets. While several modeling studies have focused on the interplay between the climate system and northern hemispheric ice sheets during the MPT, the role of Antarctica in driving and responding to climate change at that time remains largely unknown.

Here, we use the Parallel Ice Sheet Model (PISM) to simulate the transient evolution of the Antarctic Ice Sheet throughout the last 3 million years. PISM is forced by a climate index approach that is based on snapshots of climatic conditions in the past. Climate snapshots are derived from the Community Earth System Models (COSMOS), a general circulation model that simulates atmosphere, ocean, sea ice and land vegetation in dependence of reconstructions of paleogeography, orbital configuration, and greenhouse gas concentrations. Interpolation in times between snapshots is linear and based on a convolution of the EPICA Dome C record and the Lisiecki-Raymo benthic isotope stack.

Our simulations indicate that between 1.9 Ma and 800 ka BP, several Antarctic drainage basins crossed critical thresholds at different times, for example leading to the formation

of a stable marine-based West Antarctic Ice Sheet. We further examine the characteristics of these thresholds and their associated state transitions. Additionally, our findings suggest that these thresholds, and their interplay, amplified eccentricity-driven climate variability both before and during the MPT, providing new insights into the complex interactions between Antarctic ice sheet dynamics and climate during this period.

Keywords: MPT, Antarctic ice sheet

【A0129】

Intermediate water dynamic recorded by authigenic Nd isotope in the north Atlantic across the mid-Pleistocene Transition

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The Mid-Pleistocene Transition (MPT, ~1250 ka to 700 ka) is characterized as a period of intense changes in the Earth's climate system resulting in a switch from a ~40 kyr to a ~100 kyr glacial-interglacial cyclicity without an external change in orbital forcing. Several mechanisms including regolith erosion beneath the ice sheets, gradual atmospheric CO_2 decline, deep ocean circulation reorganization and the asynchronous development of hemispheric ice sheets, have been proposed to explain the emergence of the ~100-kyr cyclicity characteristic of the post-MPT world (An et al., 2024; Clark and Pollard, 2010; Pena and Goldstein, 2014). Regarding to the key role of intermediate water masses in modulating ocean heat and atmospheric pCO_2 levels, they may play a pivotal role initiating the MPT, however, their dynamics are not well constrained. Here, we present new authigenic neodymium (Nd) isotope record from ODP 982 sediment (1134 m) across the MPT. Before the MPT, unradiogenic ε_{Nd} signatures (-13.5 to -12.5) dominate during interglacial periods with a small but visible trend. In contrast, glacial periods yield an increase of ε_{Nd} signatures from -11 (1.4 Ma) to -9 (1.2 Ma). Hence, a radiogenic component appears during glacials prior to the MPT. On first order this may reflect a dominant influence (>50%) of Iceland Scotland Overflow Water (ISOW) at intermediate depths, which are continuously becoming more radiogenic when approaching the MPT. Post 1.1 Ma, interglacial climate yield more unradiogenic ε_{Nd} (-14) and glacial periods yield

more radiogenic ε_{Nd} signatures as high as -8. This finding advocate, for an enhanced decoupling of radiogenic Iceland Scotland Overflow Water (ISOW) and unradiogenic Labrador Sea water, or significant endmember changes. Notably, a regolith erosion signal around 950 ka, as suggested previously, is not recorded here. These novel authigenic Nd isotopes thus indicate a reorganization of intermediate ocean circulation, and the strong correlations between ε_{Nd} and $\delta^{18}O$ (LR04) appeal that the ice-sheet may control the intermediate water production and re-circulation in the north Atlantic. However, other factors potentially influencing the Nd isotopic composition, such as boundary exchange and sensitivity to leaching strength (sediment composition) need to be further assessed.

References:

An, Z., Zhou, W., Zhang, Z., Zhang, X., Liu, Z., Sun, Y., Clemens, S.C., Wu, L., Zhao, J., Shi, Z., 2024. Mid-Pleistocene climate transition triggered by Antarctic Ice Sheet growth. Science 385, 560-565.

Clark, P.U., Pollard, D., 2010. Origin of the Middle Pleistocene Transition by ice sheet erosion of regolith. Paleoceanography 13, 1-9.

Pena, L.D., Goldstein, S.L., 2014. Thermohaline circulation crisis and impacts during the mid-Pleistocene transition. Science 345, 318-322.

Keywords: Mid-Pleistocene Transition, Authigenic neodymium isotope, Intermediate water, North Atlantic

【A0647】

Shallow benthic foraminifera as indicator of environmental changes in Singapore

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Stable isotopic composition of planktonic foraminifera is widely used as a robust tool for paleoclimate reconstructions. However, in marginal marine environment, shallow benthic species dominate and the lack of planktonic foraminifera makes it difficult to reconstruct paleoclimate using this method. To this end, we investigate the distribution and stable isotopic composition of shallow marine benthic foraminifera from Singapore to determine its suitability as proxies for environmental and rainfall changes in the local region. Generally, Singapore experiences the highest amount of rainfall during the Northeast monsoon period (December to March). Surface sediment samples are collected from several sites around Singapore monthly from August 2023 to October 2024, and analysed for their grain size distribution, carbon content and $\delta^{13}C_{sediment}$. Water parameters such as salinity, temperature, $\delta^{18}O$ and $\delta^{13}C_{DIC}$ are also measured. Foraminiferal assemblage of each sampling site is determined and dominant species are identified. *Asterorotalia pulchella* was found to dominate in areas with sandy substrate and *Ammonia* species are prevalent in muddy sediments with relatively high carbon content. Stable isotopic measurements were conducted on these dominant species and results were compared to the rainfall amount and other environmental variables to determine if they are sensitive to rainfall and/or environmental changes, and hence evaluate their suitability as proxies for paleoenvironment and paleoclimate reconstruction.

Keywords: Foraminifera, Singapore, Environmental change, Sediments

【A0520】

Chemical weathering throughout the Yarlung Zangbo river system on the Tibetan Plateau

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Chemical weathering has been considered to regulate the Earth's climate by removing CO_2 from the atmosphere over long timescales. However, whether the weathering-climate feedback can operate on shorter timescales remains controversial. Here, we investigate major and trace elements of both silt (<63 μm) and clay (<2 μm) fractions of

surface sediments collected at high spatial resolution along the course of the Yarlung Zangbo river system on the Tibetan Plateau to study the sensitivity of silicate weathering intensity to climate. We isolate the true weathering signals by defining the $\delta\alpha^{Al}E$ indices and δCIA to quantify the elemental fractionation between the clay and silt fractions. The results show increasing trends in $\delta\alpha^{Al}Ca$, $\delta\alpha^{Al}Na$, $\delta\alpha^{Al}Sr$, and δCIA downstream (eastward) along the 1700-m-long river course of the Yarlung Zangbo. These findings reveal an increase in silicate weathering intensity in response to increasing temperature and precipitation from the interior to the eastern edge of the Tibetan Plateau. Combined with correlation analysis, we believe that temperature is the primary controlling factor of silicate weathering intensity on the Tibetan Plateau, whereas precipitation plays a secondary role. Our study shows that silicate weathering intensity can respond sensitively to temperature changes in a low-temperature environment on the Tibetan Plateau at the present-day timescale. It implies that the Tibetan Plateau, with abundance of highly reactive materials, inevitably holds great potential to buffer against the warming climate and elevated atmospheric CO_2 concentration exacerbated by human activities through enhancing chemical weathering.

Keywords: River sediments, Elemental geochemistry, Chemical weathering, Yarlung Zangbo river system, Tibetan Plateau

【A0794】

Tropical surface and intermediate water changes in the northern Indian Ocean over the last two glacial terminations

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The Maldives, in the central equatorial Indian Ocean, is a shallow carbonate platform and presents the ideal repository between atmospheric and oceanographic interactions with

tropical climate events. We present high-resolution $\delta^{13}C$ and $\delta^{18}O$ records of five planktonic foraminiferal species (*Globigerinoides ruber*, *Trilobatus sacculifer* (w/o sac), *Neogloboquadrina dutertrei*, *Pullentina obliquloculata*, and *Globorotalia menardii*) and one benthic species (*Cibicidoides sp.)* from International Ocean Discovery Program (IODP) Site U1467 to monitor tropical oceanographic changes. These records span Marine Isotope Stage (MIS) 6 to the present and reveal $\delta^{13}C$ minima in all six species at Termination II and the most recent deglaciation (Termination I). The amplitude of these $\delta^{13}C$ minima within planktonic and benthic foraminiferal species varies by around ~0.5‰ to 0.2‰. This implies temperature dependent equilibrium from the atmospheric $\delta^{13}C$ across the vertical profile of the Maldivian Inner Seaway. We detangle nutrients from air-sea gas exchange with paleo-nutrient proxy Cd/Ca and reveal nutrient depleted, oligotrophic conditions throughout the two terminations. Evidence for air-sea gas exchange between the atmosphere and the ocean is further supported with $\delta^{13}C$ predictions derived from Mg/Ca paleotemperature matching measured $\delta^{13}C$ values in magnitude across both terminations. Our study supports recent studies confirming the global imprint of thermodynamic air-sea gas exchange on the global oceans despite different sources of mixed layer and thermocline waters. Furthermore, results from this study further support the strength of using multiple planktonic species of various depths in water column thermal reconstructions across glacial-interglacial timescales.

Keywords: Glacial terminations, Stable isotopes, $\delta^{13}C$ minima, Multi-species planktonic foraminifera

【A0618】

Reconstructing stratospheric sulfur aerosol loading for extratropical volcanic eruptions: New insights from sulfur isotopes in Greenland ice cores

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Volcanic sulfate aerosols have a significant cooling effect on Earth's climate by reflecting incoming solar radiation, with their climate impact largely determined by the altitude of sulfur dioxide (SO_2) injection. While tropical volcanic eruptions are typically more effective at producing global cooling, extratropical eruptions can also have outsized climatic impacts. The current 'transfer function' used to scale sulfate deposition in polar ice cores to high-latitude stratospheric sulfur injection is solely based on model simulations of the Laki (1783-1784) and Katmai (1912) eruptions using the GISS-E model. However, significant variability has been observed in simulated sulfate deposition when using different aerosol models, which highlights the need for empirical calibration to refine the model-based 'transfer function.

Sulfur isotope measurements ($d^{34}S$ and $d^{33}S$) have recently emerged as a powerful tool for constraining the fraction of stratospheric sulfate in ice cores. Specifically, stratospheric sulfur undergoes photochemical reactions when exposed to intense UV radiation, imparting a mass-independent fractionation (MIF) of sulfur isotopes. Here, we apply this technique to Greenland ice cores to quantify the stratospheric sulfur flux from the 1912 Katmai eruption. This provides, for the first time, an empirically derived 'transfer function' for Northern Hemisphere extratropical eruptions based on the most recent major high-latitude event. By comparing this newly developed 'transfer function' with existing and updated estimates from aerosol chemistry-climate models, we will assess whether current reconstructions of climate forcing from extratropical volcanic eruptions are appropriate, with implications for understanding the apparent greater sensitivity of climate to extratropical eruptions than tropical eruptions for a given stratospheric sulfur loading.

References:

Burke, A., Innes, H, M., Crick, L., Anchukaitis, K, J., Byrne, M.P., Hutchison, W., McConnell, J, R., Moore,K.A., Rae, J.W.B., Sigl, M., Wilson,R., 2023. High sensitivity of summer temperatures to stratospheric sulfur loading from volcanoes in the Northern Hemisphere, Proceedings of the National Academy of Sciences of the United States of America 120 (47) e2221810120.

Gao, C., Oman, L., Robock, A., & Stenchikov, G. L. (2007). Atmospheric volcanic loading derived from bipolar ice cores: Accounting for the spatial distribution of volcanic deposition. Journal of Geophysical Research 112(D9).

Marshall, L., Schmidt, A., Toohey, M., Carslaw, K. S., Mann, G. W., Sigl, M., Khodri, M., Timmreck, C., Zanchettin, D., Ball, W. T., Bekki, S., Brooke, J. S. A., Dhomse, S., Johnson, C., Lamarque, J.-F., LeGrande, A. N., Mills, M. J., Niemeier, U., Pope, J. O., Poulain, V., Robock, A., Rozanov, E., Stenke, A., Sukhodolov, T., Tilmes, S., Tsigaridis, K., and Tummon, F., 2023. Multi-model comparison of the volcanic sulfate deposition from the 1815 eruption of Mt. Tambora, Atmospheric Chemistry and Physics 18, 2307-2328.

Keywords: Volcanic forcing, Transfer function, Extratropical eruptions, Sulfur isotopes, Mass-independent fractionation

【A0077】

How can Norwegian mountain peatbogs represent useful archives to understand the effect of precipitation on peatlands carbon budget?

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There is extensive literature on temporal carbon accumulation changes in arctic and boreal peatlands in northern peatlands, but little has been achieved in comparing mountain peatlands carbon sinks capacities in wet regions such as Norway. Projections in Norway show a rise in temperature and annual rainfall with more intense seasonal events in western, eastern, and northern parts. In this context, this study hypothesizes that temporal variability of temperature and precipitation during the Holocene led to weaker and stronger evapotranspiration and moisture signals affecting local and regional vegetation in peatland ecosystems, water-table changes, and carbon accumulation capacity. This study aims in disentangling the responses of the carbon budget at different hydrological gradients during the Holocene and compare temporal carbon sink capacity of peatlands in two of the most important plateaus not only in Norway, but in Europe. Methods involve a multiproxy approach to reconstruct carbon accumulation rate, local

vegetation changes, %C and %N to investigate the relationship between the proxies and Holocene carbon changes. Results for carbon accumulation rates, show very specific trends in early, mid and late Holocene and correlation with Temperature and Precipitation reconstructed values at different stages of the Holocene.

Keywords: Peatlands, Carbon, Macrofossils, Mountain, Holocene

【A0908】

Millennial-scale evolution of South Asian summer monsoon during the late Pliocene recorded in the Yuanmou Basin, southwestern China

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Understanding the millennial-scale evolution of the South Asian summer monsoon (SASM) is essential for revealing the evolution of the monsoon system and its mechanisms. Quaternary millennial-scale (1-15 kyr period) South Asian summer monsoon (SASM) variability is well documented, and provides insights into the response of the SASM to the internal variability of the Earth system. Many studies have focused on the millennial-scale evolution of the SASM since the Quaternary, but the mechanisms of the evolution are controversial. The response of the evolution of the Quaternary millennial-scale SASM to the climate of the northern hemisphere high latitudes, as well as to low-latitude insolation and tropical ocean-atmosphere processes, has long been discussed. However, studies on the pre-Quaternary millennial-scale SASM are scarce due to the lack of reconstructed records. This has hindered our insights into the evolution of millennial-scale SASM.

In this study, we present a high-resolution (~600 y sampling resolution) geochemical and magnetic susceptibility (MS) dataset during the late Pliocene from a fine-grained lacustrine sedimentary sequence in the Yuanmou Basin, Southwest China (South Asian

monsoon regions). The sedimentary succession at Yuanmou Basin provides a window into millennial-scale regional climate change during the expansion of the Northern Hemisphere ice sheet during the late Pliocene. Our record, based on Rb/Sr and magnetic susceptibility data, captures the millennial-scale evolution of the SASM during the late Pliocene. We observe strong half- and quarter-precession signals in the Yuanmou record, with amplitude modulation synchronized with orbital eccentricity and obliquity. We have accurately identified these sub-orbital scale cycles and explored the relationship between these signals and orbital periods. Bicoherence analysis shows that observed some millennial-scale cycles (as short as 3 kyr) may be associated with nonlinear interactions with others. In addition, the observed ~3 kyr cycles may be associated with oscillations in Antarctic ice sheet (AIS) size, reflecting the response of the millennial-scale SASM to changes of the AIS. At the same time, based on previous studies, we provide an in-depth analysis of the origin of these cycle signals. Our results suggest that the half- and quarter-precession signals in the SASM may originate from the insolation and seasonal differences in the equatorial region. Together, these data demonstrate the millennial-scale response of the SASM to the low latitude insolation, as well as to the high-latitude ice sheet forcing during the late Pliocene. Our work will gain new insights into the understanding of millennial-scale SASM variability and its mechanisms.

Keywords: South Asian summer monsoon, Millennial-scale, Late Pliocene, Low-latitude insolation, Ice sheet forcing

【A0102】

Long-term dynamics of biodiversity and compositional stability of diatom community under climate warming in a mid-latitude remote lake

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Remote lakes have been recognized as ideal sentinels for global changes due to being far away from direct human intervention and being able to record the natural variabilities of lake ecosystems in sediments. In the past century, biodiversity losses and ecological

regime shifts have been detected worldwide under the context of climate warming. However, regions and biological communities are not equally represented in current findings on biodiversity and stability, such as micro-organisms in comparison to fishes in lake ecosystems, and mid-latitude regions in comparison to high-latitude counterparts. Here, we explored a freshwater alpine lake in the southeastern margin of the Tibetan Plateau and highlighted its temporal changes in biodiversity and ecosystem stability in response to environmental drivers over the past two centuries. We reconstructed terrestrial inputs from catchment and diatom community composition using paleolimnological proxies of geochemical elements and diatom assemblages and calculated temporal changes of species diversity and multifaceted stability. Under the influence of climate change, the lake environment has changed directionally after the 1920s and led to increases in species biodiversity and pairwise similarity. A stark shift in community structure and stability loss occurred around 1990 CE. Compared with the ecosystem development of arctic lakes between 1850 and 2000 CE, compositional turnover here was smaller yet continued rising. An ecological transition has occurred in the recent two decades in biodiversity and ecological stability in the mid-latitude remote lake ecosystem and the rise of biodiversity came with a loss of stability and structural heterogeneity of diatom community. Such accelerated rates of ecological changes should be paid enough attention to considering the impacts of headwaters on the lower-reach ecosystems, calling for more monitoring and observation of the mid-latitude remote ecosystems.

Keywords: Ocean, Lakes

【A0147】

Orbital variability and climatic drivers modulating the East and South Asian monsoons during the last 70 krys: New insights from the Korean vegetation

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In East Asia, climatic models simulate a striking paradox for the end of the century showing a higher increase in rainfalls during winter compared to summer. Such seasonal distribution of the precipitation conflicts with the fundamental feature of a monsoonal system, and evidences a strong decoupling with the South Asian monsoon, where moister summer and drier winter are simulated. Uncertainties are accentuated by the northern distribution of the East Asian Summer Monsoon (EASM), which is the unique monsoon system extending to the temperate region. This feature reinforces its sensitivity to subarctic climate variability and, considerably increases the challenge of identifying low versus high latitudes controls.

To address these issues, we present a new vegetation record based on the analysis of pollen grains and spores from the deep-sea core ES14-GC01 collected in the East Sea, a relevant way to estimate the seasonal hydroclimatic pattern in the Korean Peninsula. 80% of the rainfall are supplied by the EASM and vegetation tightly depends on the amount and seasonal distribution of precipitation. Our record, covering the last 70 kyrs, is compared with recently published South Asian summer monsoon (SASM)-derived vegetation records from the Bay of Bengal (IODP U1446) to evaluate the relationship between the two main Asian monsoon systems during the Holocene and the last glacial period.

Glacial vegetation in Korea is marked by a large development of steppic taxa, including *Artemisia* and *Poaceae*, which extend well south beyond the present-day summer monsoon front, revealing drier and colder conditions. From 62 to 46 ka, reinforced EASM is recorded by high percentages of the temperate broadleaved forest, composed of *Quercus Lepidobalanus*-type, *Alnus*, *Betula* and *Ulmus-Zelkova*, when obliquity reached its maximum. From 46 to 14 ka, the progressive replacement of boreal trees, *Picea* and *Abies*, by the steppic taxa, reflecting a decrease in rainfall, is reported through the MIS 3, with a maximum expansion of the steppe during the MIS 2. For the first time, our vegetation record supports a strong influence of obliquity on the EASM, as previously suggested by models but never demonstrated by data. The highest percentages of temperate broadleaved forest are recorded, between 8 and 11 kyrs, reflecting the EASM maximum during the early Holocene, characterized by the highest insolation. A progressive expansion of conifers into the temperate forest ecosystem indicates a long-

term winter cooling and reduced rainfalls through the second phase of the Holocene, mirroring the insolation pattern. At orbital scale, vegetation changes point out a common variability of Asian monsoons during the Holocene, when the East and the South Asia respond directly to the North Hemisphere insolation, as the result of reinforced land-ocean temperature contrast. Obliquity strongly affected the EASM and SASM during the last glacial but its influence triggered distinct processes. In East Asia, obliquity modulates the seasonal temperature contrast and therefore, the summer rainfall intensity and the northward distribution of the monsoon front. In contrast, its effect on the South Asian region is caused by the modulation of interhemispheric temperature gradient, which affects the position of the ITCZ.

Keywords: East Asian monsoon, Pollen-derived vegetation, Orbital scale, Holocene, Last Glacial period

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