

M G U

Michigan Geophysical Union

Annual Symposium Program Booklet

April 9-10, 2026

The University of Michigan

DOI:

EVENT SCHEDULE

THURSDAY

REGISTRATION OPEN – (3:30 PM - 4:00 PM) - NUB 2540

POSTER SESSION – (4:00 PM - 5:30 PM) - NUB 2540

A01 - *Simulating an Archean Analogue Lake to Test a Hypothesized Manganese Depositional Pathway*, **Kaylee Hodroj**

A02 - *Dynamical Moisture Transport Patterns affecting Storm Peak Laboratory, Colorado during S2noCliME*, **Crista Castillo**

A03 - *Interactions Between Atmospheric Concentrations of Hazardous Pollutants and Meteorology Data in Southeast Michigan*, **Katherine Paff**

A04 - *Working towards a Machine Learning model to predict Tornado Family Generation*, **Luka Todorovic**

A05 - *Detecting Earthquake Swarm and Analyzing their B+ trends in the Salton Trough Region of Southern California*, **Astrid Olsson**

A06 - *Sedimentology and Faunal Compositions at Bermont Excavating, Florida*, **Jordan Roth**

A07 - *More Than Just A Grain of Sand: Sedimentology and Faunal Composition at Hall's Quarry as Environmental Indicators*, **Julieta Turon**

A08 - *New Microvertebrate Fossil Assemblage from the Meeteetse Formation (Campanian-Maastrichtian) of the Bighorn Basin, Wyoming, USA*, **Ethan Davis**

A09 - *Vertebrate Microfossils from the Early Cretaceous of Zimbabwe*, **Leilani Reyes**

A10 - *Tusk growth records reveal end-of-life conditions for three Columbian mammoths (Mammuthus columbi) from central Mexico*, **Camden Strader**

A11 - *Characterizing Ion Energy Dispersions in Mercury's Northern Cusp*, **Sarah Feldman**

FRIDAY MORNING

REGISTRATION OPEN – (9:00 AM - 9:30 AM) - BSB

POSTER SESSION – (9:30 AM - 10:45 AM) - BSB

B01 - *The enigma of manganese in Banded Iron Formations deposited prior to the Global Oxidation Event*, **Kaitlin Koshurba**

B02 - *Unraveling Nitrogen Preference in Lake Erie Microcystis Blooms Using Stable Isotope Probing Metagenomics*, **Rob McManus**

B03 - *Nitrogen dynamics in winter and spring microbial communities in Western Lake Erie*, **Abigail Reed**

B04 - *Perspectives on COP30: Implications of the US Withdrawal from the UNFCCC and the Paris Agreement*, **Lisa Nguyen**

B05 - *Modeling atmospheric microplastics in the Great Lakes region*, **Anna Schellin**

B06 - *Marine-based Multiproxy Reconstruction of the Tropical North Atlantic SST Reveals Variability Associated with the Atlantic Multidecadal Oscillation*, **Joelle Tanuputri**

B07 - *Phenotypic Diversification of Spiny Eels Across the Fragmented Freshwaters of the Afro-Tropics*, **Lindsey DeHaan**

B08 - *The role of landsliding in steep mountain hydrology*, **Sally Keating**

B09 - *Coeval Porphyry Cu-Au-Mo and Iron-Oxide Copper Gold Mineralization in the Llahuín-El Espino District, Chile*, **Andres Felipe Gonzalez-Duran**

B10 - *Iron disproportionation in ultramafic silicate melts: Implications for magma ocean redox evolution*, **Jiaqi Lu**

B11 - *Effects of Residential Load-Shifting Technologies and Climate Change on Bulk Power*

System Resource Adequacy, **Martha Christino**

B12 - *Temperature and circulation history of the Cretaceous Western Interior Seaway derived from bivalve clumped isotope geochemistry*, **Adriana Brown**

B13 - *Clumped and Triple Oxygen Isotope Constraints on Vegetation and Water-stress across Rift landscapes of the Mid-Pliocene Lower Awash Valley, Ethiopia*, **Million Mengesha**

B14 - *Tooth imbrication and enamel wrinkling as adaptations for herbivory in sauropodomorph dinosaurs*, **Lynnea Jackson**

B15 - *A Pennsylvanian fish highlights mosaic character-state evolution among Paleozoic ray-finned fishes*, **Zach Lyons-Weiler**

B16 - *First report of a fossiliferous late Holocene stratigraphic record from an Amazonian forest inventory plot* , **Theodore Matel**

B17 - *Unexpected Experimentation With Life History Strategies In Early Therians*, **Jared Shiffert**

B18 - *Topographic diversity gradient revealed among latest Cretaceous mammals*, **Rory Sweedler**

B19 - *Comparing DMSP-SSUSI Observations to Models of the Auroral Oval*, **Michelle Bui**

B20 - *Solar Wind and Magnetospheric Drivers of Omega Band Substorm Activity*, **Vivian Cribb**

B21 - *Determining the boundaries of the Earth's space environment*, **Marloes van der Zwart**

B22 - *Contrasting behavior between H2O and Na2O during glass bead evolution in lunar gas plumes*, **Ziqi Yang**

ORAL SESSION – (10:45 AM - 12:00 PM) - NUB 2548

C01 - *Remote Sensing of Hydroclimatic Variability: Thirty Years of Urbanization Induced Surface Runoff Increases in Bangkok, Thailand,* **Gary Bowen**

C02 - *Validating sampling and data-processing methods in high-resolution carbonate clumped isotope (Δ47) sclerochronology using Mercenaria mercenaria for reconstructing paleoseasonality,* **Yunhan Fang**

C03 - *Identifying Marine Organics Within Arctic Sea Spray Aerosols Using O-PTIR Spectroscopy,* **Cody Stark-Vernier**

C04 - *Expanding the Toolkit: An assessment of new mollusk species for isotopic sclerochronology,* **Anna Salazar**

LUNCH – (12:00 PM – 12:45 PM) – NUB 2540

FRIDAY AFTERNOON

ORAL SESSION - (1:00 PM - 2:15 PM) - NUB 2548

D01 - *The Influence of EDTA on Fe(III) interactions with Sodium Strong Acid Cation Exchange Resin,* **Alexander Thompson**

D02 - *Quantifying U.S. Mid-Atlantic Coastal Plain Ocean Temperatures and d18Owater Values from the Late Miocene and Pliocene Using Molluscan Clumped Isotopes,* **Erin Kim**

D03 - *Identifying Ultra Low Frequency Waves and their Impact on the Coupling of Space Environments,* **Nolan Tribu**

D04 - *Constraining the Age and Thermal Structure of a Mesozoic Subduction Zone; Cedros Island, Baja California, Mexico,* **Sam Neumann**

D05 - *Reconstruction of Plio-Pleistocene paleoenvironment at Buck Hammock Quarry, Florida* **Alexandra Curley**

POSTER SESSION - (2:15 PM - 3:30 PM) - BSB

E01 - *The Impact of Canada's Record-Breaking Forest Fires on Surface Fluxes Across the Upper Midwest US,* **e schwartz**

E02 - *Ammonium uptake and regeneration across the Laurentian Great Lakes ,* **McKayla Dzyngel**

E03 - *Between Tides and Time: Integrating Landsat and SAR to Quantify Species-Level Structural Differentiation and Climate-Driven Dynamics in Gambian Mangroves ,* **Betty Jahateh**

E04 - *Inland Lake Wind Speed Retrieval: Integration of SWOT and CYGNSS Observations via Cluster-Specific Random Forest Models,* **Yinjiao Zhong**

E05 - *Assessing the Role of Northwest Indian Ocean Warming in Long-term Eastern Central India Drying,* **Yunfan Chen**

E06 - *Tracking Seasonal and Spatial Shifts in Lake Erie Using Stable Isotope Geochemistry,* **Jada Langston**

E07 - *Incorporating aerosol emissions of freshwater lake harmful algal blooms (HABs) into an atmospheric model,* **Jennifer Seth**

E08 - *Effects Of Increased Temperature And Acidification On Freshwater Nitrification Rates And Gene Expression During A Cyanobacterial Harmful Algal Bloom,* **Colton Bragg**

E09 - *Thermal Constraints on the Transition Between the Marlborough Fault System and the North Canterbury Fold and Thrust Belt, South Island, Aotearoa New Zealand,* **Madison Huising**

E10 - *Tracking hydrothermal processes with magnetite composition and texture at the Quebrada Blanca Cu-Mo porphyry deposit, Chile,* **Amanda Holmes**

E11 - *Using Isotope Geochemistry to Promote Ethical Sourcing of Gold via Mine Level Fingerprinting,* **Anne Lammes**

E12 - *Timing of metamorphism in the English River Subprovince through Lu–Hf garnet dating.,* **Hannah Schroeder**

E13 - *Experimental Studies of Equilibrium Triple Oxygen Isotope Fractionations in the Dissolved Inorganic Carbon System,* **Jungpyo Hong**

E14 - *Evaluating Miocene Temperature, Water Stress, and Hydrological Variability in the Atacama Desert with Carbonate Clumped and Triple Oxygen Isotopes,* **Elena Lee**

E15 - *Obliquity Response in Bulk Sediment Geochemistry Across the Eocene-Oligocene Transition,* **Corinne Renshaw**

E16 - *Miocene megaflora of Cuenca Basin in Ecuador: composition and fossil plant descriptions,* **Tyler Carpenter**

E17 - *Kirkiaceous fruits from the Late Cretaceous of James Ross Island, Antarctica,* **Kaitlyn Krinsky**

E18 - *Exploring Leaf Hydraulics in Campanian Antarctic Conifers,* **Laura Puente**

E19 - *Marine tropical fossil fishes throughout the Cenozoic of the Indo-West Pacific: a paleontological perspective,* **Hadeel Saad**

E20 - *Insights into dietary niche partitioning among archaic ungulates from the early Paleocene of the Denver Basin revealed by dental microwear textures,* **Athena Vohs**

E21 - *A Multi-Spacecraft L1 Solar Wind Pipeline with Causality-Enforcing Propagation for SWMF Boundary Conditions,* **Connor DiMarco**

E22 - *Meso-scale Polar Cap Flows and their Impact on Polar Cap Patch Evolution,* **Amelia Lee**

E23 - *Reconnection potential via Null-based Extraction and Utilization System (RECONEXUS) - A Novel Approach to Evaluating Dayside Reconnection in MHD Models,* **Amy Rewoldt**

E24 - *Shall We Split? Foraminiferal Reproductive Regime Shifts in Response to Environmental Instability During the Little Ice Age in Santa Barbara Basin, California*, **Jackson Lee and Adelaide Hamm**

E25 - *Compound-specific nitrogen isotope composition of a meromictic freshwater strain of Synechococcus*, **Olivia Eilf**

INVITED SPEAKER LECTURE - (3:30 PM - 4:30 PM) - NUB 1528

A mechanistic framework for the formation and evolution of chemical biosignatures in

microbialites - **Dr. Amanda Oehlert**

RECEPTION – (4:30 PM-5:30 PM) – NUB 2540

22nd ANNUAL Michigan Geophysical Union APRIL 9-10, 2026

Simulating an Archean Analogue Lake to Test a Hypothesized Manganese Depositional Pathway

Hodroj, Kaylee A.[1], Koshurba, Kaitlin N.[1], and Johnson, Jena E.[1]
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Archean oceans were characterized by anoxic, reductive conditions prior to the rise of atmospheric oxygen during the Great Oxidation Event. Fayetteville Green Lake (FGL) has been proposed as an analogue for these paleoenvironments, particularly for its meromictic stratification and enrichment in redox-sensitive metals like manganese(II). Manganese-rich carbonate deposits observed in the post-Archaean sedimentary record are conventionally interpreted as diagenetic products of sedimentary manganese oxides, and therefore indicative of oxygen in the depositional environment. However, primary carbonate minerals with manganoan carbonate rims have been documented in ancient and modern anoxic sediments, leading to an emerging view that challenges the established diagenetic interpretation. The hypothesized primary precipitation pathway suggests localized reductive environments enriched in Mn^{2+} could drive manganiferous carbonate deposition with nucleation by calcium carbonates. However, no research has replicated relevant hydrochemistry under controlled conditions to evaluate the proposed pathway. In this case study, we simulated the published hydrochemical conditions of FGL as a representative of the hypothesized pathway to observe Mn-mineral formation during calcite whiting events. Hydrochemical conditions were replicated in an anoxic glovebox and solutions were agitated under environmentally relevant temperatures for two weeks. Calcite was synthesized and verified with Raman microspectroscopy and X-ray diffraction (XRD) prior to its addition to our simulated water column chemistries as a nucleating seed. Solids formed during our incubations were characterized using Scanning Electron Microscopy, energy-dispersive spectroscopy, Raman, and XRD to discern inclusion of manganese(II) in mineral structures. Our future work will replicate the hydrochemistries of other Archean analogue lacustrine environments to appraise the proposed primary precipitation pathway of manganese deposition. Our results will further constrain the diagnostic interpretation of depositional redox conditions for sediments hosting manganese carbonates.

22nd ANNUAL Michigan Geophysical Union APRIL 9-10, 2026

Dynamical Moisture Transport Patterns affecting Storm Peak Laboratory, Colorado during S2noCliME

Castillo, Crista[1], Bailey, Adriana[1], and Pettersen, Claire[1]
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Precipitation is an essential ingredient in mountain regions that provide critical ecosystem services to communities. Yet, predicting precipitation amount, intensity, and duration is difficult, as precipitation events depend on multiple moisture processes that cover vast spatial scales. These processes include the large-scale transport of moisture by synoptic wind patterns, physical interactions of atmospheric flow with mountain topography, and the effects of aerosol particle interactions on clouds. S2noCliME (Snow Sensitivity to Clouds in a Mountain Environment) was a field campaign, centered around the Storm Peak Laboratory, in Northwestern Colorado from December 2024 to April 2025, that set out to evaluate these processes and their effects on mountain snowfall. In this study, our goal is to understand the large-scale moisture transport pathways that characterized the season in which the campaign measurements were made. We also aim to compare and contrast the large-scale moisture transport dynamics of IOP events (Intensive Observation Periods, in which precipitating storms developed) against non-IOP days. To classify the large-scale dynamical patterns that characterized the S2noCliME season, we use daily wind and specific humidity from ERA5 reanalysis to map composites of Integrated Vapor Transport (IVT) and vector winds at 200 and 500 hPa pressure levels. We also use stable water vapor isotope measurements from Storm Peak Laboratory to distinguish periods in which moisture was sourced from distinct regions. Interestingly, after identifying dominant moisture transport patterns using both manual and K-means clustering techniques, we find that precipitating storms developed across a wide range of large-scale transport conditions. These results suggest an important role for smaller-scale processes in favoring precipitation development. Ultimately, this work is a step toward understanding the processes underlying the precipitation events that characterized the S2noCliME measurement campaign and for elucidating the conditions that favor snowfall in mountain regions broadly.

22nd ANNUAL Michigan Geophysical Union APRIL 9-10, 2026

Interactions Between Atmospheric Concentrations of Hazardous Pollutants and Meteorology Data in Southeast Michigan

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Criteria air pollutants, including carbon monoxide, lead, nitrogen dioxide, particulate matter, sulfur dioxide, and ozone, are regulated by the United States Environmental Protection Agency (EPA). One of the widely monitored pollutants is ozone, due to its negative impacts on human health and ecosystems and its prevalence in smog events in urban areas. Because of this importance, it is important to understand the drivers of ozone events. Ozone is formed by a secondary reaction in the atmosphere between Nitrogen Oxides (NOx), Volatile Organic Compounds (VOCs), and sunlight. In Detroit Michigan, there have been multiple complaints stemming from VOC emissions because many VOCs have a distinct smell and are unhealthy for individuals to inhale. These VOC emissions are created from petroleum refineries such as Marathon Petroleum, as well as other manufacturing facilities.

In this study, Volatile Organic Compound (VOC) data was evaluated from five observation sites surrounding the Marathon Petroleum Refinery located in Detroit, Michigan from 2012-2022. In the Detroit area, Marathon is one of the larger sources of VOC emissions. In the past, there have been multiple formal odor complaints, as well as documented violations of VOC emissions from the refinery.

The purpose of this study was to analyze these violations and examine how meteorology, especially the winds and boundary layer dynamics, played a role in these high VOC events. By evaluating the winds and meteorological vertical profile data, we will examine how the meteorology influenced the VOC concentrations at the site. VOCs to be analyzed include BTEX compounds (Benzene, Toluene, Ethylbenzene, and xylene, specifically o
xylene, m-xylene, and p-xylene), which are commonly produced from petroleum processing. Over the dataset, we will identify high BTEX concentrations (>2 standard deviations above the means) to define specific potential emissions events. For these events, we will evaluate odor violations and meteorological conditions to understand potential causes for extremely high concentrations.

22nd ANNUAL Michigan Geophysical Union APRIL 9-10, 2026

Working towards a Machine Learning model to predict Tornado Family Generation

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An increasing focus of literature in the prediction of severe convective storms (SCSs) is the intersection of Machine Learning techniques and real-time environmental parameters. There has been a particular interest in the utilization of different Machine Learning techniques and models in tornadic prediction, with studies showing promise with classification models such as random forests as well as neural network methods such as Convolutional Neural Networks (CNNs) and Generative Adversarial Networks (GANs). SCS research also focuses on the usage of State-Space Models (SSMs) such as Mamba and Weather State-Space Models utilized in forecasting. This review aims to provide a theoretical discussion of the process required to create a model to predict tornado family generation given confirmed discrete supercell tornadogenesis using a two-pronged approach. First, the paper aims to analyze possible Machine Learning candidate models that may be effective at such prediction. This is followed with a discussion into the necessary data and current state of such data that would be necessary to building such models. The result of this work will be recommendations for future research that may attempt to build such models.

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Detecting Earthquake Swarm and Analyzing their B+ trends in the Salton Trough Region of Southern California

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The Salton Trough region of Southern California is known for having short, frequent earthquake swarms. Defining swarms in this region is challenging because they are often brief and do not exhibit many of the patterns typically associated with longer-duration swarms. Additionally, the high overall level of seismicity further complicates distinguishing short swarms from background activity. However, because the area is highly populated, frequent earthquakes pose a significant hazard to the local population. Therefore, we apply two methods to detect earthquake swarms and examine whether swarms are associated with changes in earthquake statistics. We analyze the temporal and spatial variations in b-values that quantify the magnitude-frequency distribution. The b-value variations have been shown to serve as an indicator of changes in earthquake behavior and thus may reveal periods when swarm-like activity is more likely to emerge.

To ensure the robustness of earthquake swarm detections, we first apply the nearest neighbor method (Zaliapin & Ben-Zion, 2020) and the clustering method from Chen and Shearer (2011) to identify swarms in the Salton Trough region. By comparing results from two different methods, we create a more complete swarm catalogue, spanning 1981 to 2023. With the revised catalogue, we observe an average offset between swarm identification methods of 1.36 km and a mean temporal median offset of 0.28 days between the median locations, indicating a strong correlation between swarm identification methods. The swarms we find last, on average, about 10 days, ranging from less than a day to 16 days. Swarm events are spatially concentrated, with most events within a few kilometers. We also observe alternating periods of higher (1981-1986, 1996-2012, 2016-2024) and lower (1986-1996, 2012-2016) swarm activity.

To examine spatial and temporal changes in b-values associated with detected swarms, we use the b+ method (van der Elst, 2021), which is based on the distribution of magnitude differences and is more robust to incompleteness of the earthquake catalog. We find b+ spatial trends largely coincide with large-magnitude events; however, we do not identify a consistent relationship between the temporal variations of b+ and the occurrence of swarms for the whole region, suggesting b+ is not a reliable predictor of swarm activity at the regional scale. These findings indicate regional b+ variations primarily reflect large-scale stress interactions rather than swarm-driven processes, underscoring the complexity of forecasting swarm activity in the Salton Trough and the necessity for improved methods to

characterize short-duration swarms in regions with high background seismicity.

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Sedimentology and Faunal Compositions at Bermont Excavating, Florida

Roth, Jordan[1], Turon, Julieta[1], Waters, Eric[1], Gomes, Lucas[1], and Petersen, Sierra[1,2]

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Understanding changes in environmental conditions, sedimentology, and faunal compositions is necessary to investigate the past climate of Southern Florida during the late Pliocene to early Pleistocene. Past and ongoing research at sites in and around Southern Florida have identified a local marine mass extinction and have characterized past climate. However, more research is necessary to gain a complete picture of the past environment throughout this time. Lateral variations in stratigraphy can produce signals that only reflect local events and may not represent conditions in the broader region as a whole. Therefore, it is important to take into consideration lateral variations in stratigraphy and compare geologic formations of this age from multiple different sites.

In this study, we analyze sediment grain size and taxa composition from bulk sediment samples collected from various stratigraphic heights at Bermont Excavating in Punta Gorda, Florida. These samples were collected from 4 geologic formations; the Fort Thompson Formation (late Pleistocene), the Bermont Formation (mid Pleistocene), the Caloosahatchee Formation (late Pliocene to early Pleistocene), and the Ochopee Limestone Member, part of the Tamiami Formation (Pliocene). Thirty-eight samples were sieved and separated into six different size fractions and then weighed to calculate fractional abundances. Bivalves and gastropods from the largest two size fractions of each bulk sample were identified to the genus and/or family level. We compare taxa composition and sediment fractional abundance from Bermont Excavating to data collected from the same geologic formations and time period from two nearby sites called Hall's Quarry and Florida Shell Quarry, both in Charlotte County, Florida. Comparing data between these and other sites can help distinguish between signals produced by local stratigraphic variation and signals caused by widespread environmental events/factors. This helps to create a better understanding of broad regional changes throughout the Plio-Pleistocene in Southern Florida and gives insight into the reliability of this sampling process across locations.

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More Than Just A Grain of Sand: Sedimentology and Faunal Composition at Hall's Quarry as Environmental Indicators

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From the Pliocene to today, molluscan assemblages in Florida and the greater Western Atlantic experienced dramatic faunal turnover, which has been labeled a regional molluscan mass extinction event. This event has been studied in various geologic formations across the Southeastern United States, with a particular focus on Florida. Our understanding of the cause and effects of this mass extinction event, however, are limited by a lack of spatial reproducibility. The variation in faunal and sediment grain size throughout Floridian sites provides an obstacle in determining if environmental trends at different sites are local or regional. This study aims to enhance our understanding of changes in environment throughout the late Pliocene and early Pleistocene by replicating similar surveying done in other Florida locations at a new and previously unstudied site.

In this study, thirty-nine bulk samples were taken from Hall's Quarry in Charlotte County, Florida. Bulk sediment samples averaging between 1.1 and 1.3 kilograms were collected at different stratigraphic heights from the Fort Thompson, Bermont, and Caloosahatchee formations. Collection included sampling from different sections of the quarry in order to gain a complete understanding of the full stratigraphy present. These bulk samples were dried and later sifted using industrial sieves into 6 layers, the two largest (F1 and F2 layers) of which were later analyzed to understand taxonomic abundances. The ratio of different particle sizes and families of species at different stratigraphic heights tells us about the type of paleoenvironments (riverine, estuarine, saltwater) present during the time of these formations. These analyses are directly comparable to previous assessments done at other Florida sites, allowing us to compare local changes in environmental conditions at each site to broader regional changes in paleoclimate.

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New Microvertebrate Fossil Assemblage from the Meeteetse Formation (Campanian-Maastrichtian) of the Bighorn Basin, Wyoming, USA

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Empirical studies of terrestrial ecosystem evolution approaching the end-Cretaceous mass extinction in North America have largely focused on a narrow interval of time (ca. 2 million years) just prior to the mass extinction. This is because the early Maastrichtian (ca. 72–68 million years ago, Ma) was a time of marine transgression in the Western Interior Seaway of North America, leaving a gap in the terrestrial rock record, limiting the amount of fossil data recording terrestrial ecosystem evolution from this time. One hypothesis explaining terrestrial ecosystem assembly during the Late Cretaceous is latitudinal biogeographic provinces, but much of the data supporting this idea is from far to the north and south; very little comes from the purported transition zone which was located approximately across modern-day Wyoming. A continuous stratigraphic record spanning this time represented by the Mesaverde, Meeteetse, and Lance formations in the Bighorn Basin of Wyoming helps fill this temporal and geographic gap. Existing litho- and biostratigraphic correlations suggest the Mesaverde Formation is late Campanian, and the Lance Formation is late Maastrichtian in age. Thus, the Meeteetse Formation is likely equivalent to the early Maastrichtian. The Meeteetse Formation is composed of floodplain muds with isolated channels and preserves vertebrate microfossils, which we describe here. In this study, we collected sediment from three localities within the Meeteetse Formation: Josephine's Rump, Cale's Clam Cache, and Dumbbell Hill. 4,196 kg of sediment was collected, with 2,722 coming from Josephine's Rump, 113 from Cale's Clam Cache, and 1,361 from Dumbbell Hill. After collection, sediment was screenwashed in the field and lab with coarse mesh (.017") and fine mesh (.012") to ensure collection of small fossils, like mammal teeth. Following screenwashing, we sorted sediment under a microscope and identified fossils to the lowest taxonomic level possible. Preliminary observations indicate the presence of actinopterygian fish, mammals, lizards, turtles, theropods, crocodilians and chondrichthyians, expanding knowledge of vertebrates from this understudied place and time. Previously, just one site had been

described, this study adds three more produced sites to the knowledge of the formation. This study also contributes to our knowledge of proposed biogeographic provinces in the early Maastrichtian. Understanding terrestrial ecosystems from this time interval, and its surrounding time intervals, will help us build a long record of ecosystem and faunal composition change leading up to the end-Cretaceous mass extinction.

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Vertebrate Microfossils from the Early Cretaceous of Zimbabwe

Reyes, Leilani S.[1,2], Rodriguez, Aidan C.[1,2], Zondo, Michel[3], O'Connor, Patrick M.[4], Munyikwa, Darlington[5], Roberts, Eric M.[6], and Weaver, Lucas N.[1,2]

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The Gokwe Formation in the Midlands Province of Zimbabwe has been known to be fossiliferous for Mesozoic reptiles (especially non-avian dinosaurs) since the 1960s. Composed of a lower Calcareous Member and the upper White Sandstone Member, the formation is poorly exposed and heavily vegetated, yet the latter member is highly productive for vertebrate fossils. Although abundant in fossil bone, the Gokwe Formation produces mostly fragmented and weathered fossils, few of which are identifiable. Productive vertebrate fossil assemblages from the Early Cretaceous of southern Africa, are rare due in part to mainland Africa being an erosional setting for much of that time; as such, our knowledge of the fauna on the continent at this time has been quite poor. Previous studies of the Gokwe Formation vertebrates have indicated the presence of titanosaurian sauropods, theropods, crocodyliforms, turtles, ganoid fish, and bivalves. In the summer of 2025, our field team revisited exposures of the Gokwe Formation, prospecting for and collecting vertebrate fossils on the surface, collecting fossiliferous sediment for underwater screenwashing, assessing local sedimentology and stratigraphy, and collecting rock samples for geochronological analyses. Preliminary geochronological results from radiometric dating of detrital zircons from the White Sandstone Member suggest a maximum depositional age of 130.14 ± 3.5 Ma (Valanginian-Barremian; Early Cretaceous), representing the first absolute age constraint on the Gokwe Formation deposition. Paleontologically, sediments collected for screenwashing underwent repeated wetting and drying cycles that allow the matrix to break up, while leaving behind a smaller grain size fraction and fossils. This

process revealed a surprising richness of fossils that belong to smaller taxa or are small elements of large taxa. To date, we have meticulously sorted through only a small fraction of this washed sediment, picking out these small (<1cm) fossils under a microscope. The most notable result of the microfossil sorting so far is a cheek tooth of an allotherian mammal, adding to the very sparse record of Cretaceous mammals known from mainland Africa. Additionally, we have found fossils of theropods, crocodyliforms, and squamates, many of which are likely new records for the formation. This preliminary study furthers our understanding of the diversity of the Gowke Formation, yielding insights into the richness of its vertebrate fauna present.

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Tusk growth records reveal end-of-life conditions for three Columbian mammoths (*Mammuthus columbi*) from central Mexico

Strader, C.R.[1]*, Cherney, M.D.[2], Fisher, D.C.[1], Shirley, E.A.[1], Beld, S.[1], Morett-Alatorre, L.[3], and Arroyo-Cabrales, J.[4]

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Paleontological sites in the Mexico Basin show concentrations of mammoth bones in association with human archeological sites, but little is known about how these southern populations of mammoths lived and died. To this end, we examined dentin extracted from the proximal ends of three Mexican tusks (two from Tocuila, one from Tequexquináhuac). Efforts to recover steroid hormones and collagen for ^{15}N and ^{13}C were unsuccessful due to excessive degradation of organics. Bulk carbonate ^{18}O from the three specimens was within the range of other central Mexico specimens. Although bulk carbonate ^{13}C for the Tequexquináhuac tusk fell within the expected range based on published values, ^{13}C results for the Tocuila tusks were higher than expected, suggesting that dentin carbonate ^{13}C is diagenetically altered in these specimens. Annual growth features visible in micro-CT data align with the start of a low productivity season of year marked by decreasing dentin apposition rates according to thin-section growth increment analyses. Using this seasonal interpretation, the Tequexquináhuac tusk reveals death during the season of slowest growth, when resources were scarce. In contrast, both of the Tocuila records suggest death occurred when growth was increasing, presumably a time with plentiful resources. The relative stability of ^{18}O in our serial analyses suggests minimal seasonality, or possibly that mammoths were able to move around the landscape to find water and food sources with consistent isotopic signatures through time. These analyses help paint a picture of mammoths' interactions with their environments in late Pleistocene Mexico and how growth, development, and behavior changed during times of variable resources.

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Characterizing Ion Energy Dispersions in Mercury's Northern Cusp

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Mercury's magnetic field is significantly more dynamic than Earth's, which is due to the planet's proximity to the Sun combined with its weak magnetic field. These conditions result in a two-minute Dungey cycle and dayside magnetic reconnection rates that are an order of magnitude higher than those seen at 1 AU. When this magnetosphere interacts with the solar wind, energy is transported into the magnetosphere through magnetic reconnection, creating high-speed plasma flows and temperature increases. The ions and electrons then follow open field lines across Mercury's northern cusp, the region where the field connects to the surface. Despite the smaller Hermian magnetosphere, Mercury has the largest relative cusps of any planet in the Solar System, making them a key region of mass and energy transport from the dayside to the nightside of the planet and back. Cusps are characterized by in-situ signatures known as ion energy dispersions. A 'classical' or 'forward' dispersion appears as higher energy particle flux counts decreasing with increasing magnetic latitude, while a 'reverse' dispersion exhibits the opposite trend. With data from the MErcury Surface, Space ENvironment, GEochemistry, and Ranging (MESSENGER) mission's Fast Imaging Plasma Spectrometer (FIPS) and Magnetometer (MAG), which orbited Mercury from 2011 to 2015, these dispersions can be identified and measured. This study focuses on expanding our understanding of this region, with the intention of utilizing Mercury's ion energy dispersions as a way to determine the topology of Mercury's magnetopause under different conditions. Currently, work is being done to broaden our understanding of conditions that create classical or reversed dispersions, as well as to confirm the quasi-steady state nature of Mercury's northern cusp. Out of 2,760 identified northern cusp crossings throughout MESSENGER's mission, the dispersions are being categorized to confirm the understanding that the latitude of the open-closed field line boundary above or below the cusp is related to the dispersion type. Work is also being done to determine if the lower extent of the cusp is dependent on local time. This would allow for a stronger understanding of how upstream solar wind conditions not only impact the magnetopause but also how those particles travel through the dayside magnetosphere.

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The enigma of manganese in Banded Iron Formations deposited prior to the Global Oxidation Event

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The anoxic Archean Earth, predating the 2.45 Ga Global Oxidation Event (GOE), consisted of a strikingly different oceanic chemistry compared to the modern environment. The Archean Ocean was characterized by the accumulation of reduced aqueous metals, including iron (Fe^{2+}) and manganese (Mn^{2+}), driven by a reducing ocean coincident with Earth's anoxic atmosphere. The Archean Ocean also contained silica at near saturation concentrations, as silica
biomineralizing organisms would not evolve until the Paleoproterozoic Era. This markedly different oceanic chemistry led to the deposition of Banded Iron Formations (BIFs), which are iron- and silica-rich layered deposits unique to the Precambrian ocean. With a poor fossil record prior to 2 Ga, BIFs record metal (bio)geochemical cycling of the Archean. Despite the enrichment of Mn in the Archean Ocean that was fueled by the absence of the Mn-(oxyhydr)oxide sink, pre-GOE BIFs contain notably low Mn concentrations. Hypothesized initial progenitors of BIFs include phases with oxidized iron, such as iron oxides and green rust, which would likely involve iron redox cycling and exclude reduced Mn^{2+}. However, an emerging view proposes that the iron silicate greenalite [$Fe^{2+}{}_3Si_2O_5(OH)_4$] was the precursor phase of BIFs. It is unknown whether greenalite incorporates aqueous manganese during its formation, but this behavior could indicate the plausibility of this mineral as a precursor. We synthesized greenalite under reducing conditions in synthetic seawater solutions containing variable aqueous Mn and dissolved inorganic carbon concentrations to assess whether Mn would be incorporated into the silicate's structure. Computational simulations were performed alongside our experiments to assess the thermodynamic feasibility of the substitution of Mn^{2+} for structural Fe^{2+}. All experimental conditions yielded a Mn-free greenalite and Mn was excluded from the final mineral assemblage under most Mn^{2+} concentrations, despite our computational results suggesting the thermodynamic favorability of this elemental substitution. Our experimental findings are consistent with the BIF record and suggest that greenalite, formed without O_2 or other redox activity, is a viable precursor mineral to generate Banded Iron Formations. Our results also suggest a second, potentially kinetic rather than thermodynamic, control prevented manganese mineralization during the Archean.

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Unraveling Nitrogen Preference in Lake Erie *Microcystis* Blooms Using Stable Isotope Probing Metagenomes

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Nitrogen dynamics in winter and spring microbial communities in Western Lake Erie

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Lakes globally, including the Great Lakes, are experiencing shifts in their winter conditions as the climate warms. Due to a historical lack of Great Lakes winter sampling, the impacts of winter regime shift on nitrogen (N) cycling and phytoplankton communities are unknown. We used ^{15}N tracer methods to evaluate monthly reduced N uptake and regeneration rates, nitrate uptake rates, and nitrification rates in Western Lake Erie (WLE). N cycling rates followed seasonal patterns. Under-ice nitrification occurred at low and steady rates that support the under-ice nitrate pool for diatoms. Spring nitrification rates were high, which coincided with high external loading of nutrients, high nitrate consumption, and abundant diatoms. Summer nitrification rates were low, but the recycling of reduced N appeared to sustain cyanobacterial-dominated communities after diatom dominance waned. We present preliminary results of a multi-year project aiming to record monthly N cycling rates in eutrophic Great Lakes systems. Our results will inform modelling efforts to understand diatom N demands within WLE and the annual WLE N budget.

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Perspectives on COP30: Implications of the US Withdrawal from the UNFCCC and the Paris Agreement

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Each year, the University of Michigan sends a delegation of students and researchers to observe and engage with the United Nations Framework Convention on Climate Change (UNFCCC) Conference of the Parties (COP). COP30, held in Belém, Brazil in 2025, occurred during a pivotal moment for international climate policy. The United States has not only initiated its withdrawal from the Paris Agreement, but also its unprecedented withdrawal from the entire UNFCCC. However, climate action did move forward in 2025, with countries being required to submit updated Nationally Determined Contributions (NDCs), outlining their climate mitigation and adaptation commitments for the coming decade. This poster aims to introduce audiences to the UNFCCC process while sharing perspectives from COP30 on how these developments shaped the conference. The poster provides a brief overview of how COP functions and highlights several of the major issues discussed during the negotiations, including the submission and ambition of new NDCs, adaptation finance for vulnerable countries, and the development of international carbon markets under Article 6 of the Paris Agreement. Particular attention is given to how the anticipated absence of U.S. participation influenced the tone and priorities of discussions, as other countries and regional coalitions emphasized continued progress toward global climate targets. By summarizing key themes from COP30, this poster aims to help audiences better understand the international climate negotiation process and the broader implications of geopolitical shifts for global climate governance.

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Modeling atmospheric microplastics in the Great Lakes region

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Marine-based Multiproxy Reconstruction of the Tropical North Atlantic SST Reveals Variability Associated with the Atlantic Multidecadal Oscillation

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On decadal+ (interdecadal and multidecadal) timescales, sea surface temperature (SST) in the Tropical North Atlantic (TNA) drives regional hydroclimate extremes and is closely linked with Atlantic low-frequency SST variability known as the Atlantic Multidecadal Oscillation (AMO). This relationship is evident in the instrumental period, but insights into how AMO changes through time require independent indices that extend beyond the relatively short instrumental record. Previous efforts to reconstruct past AMO indices using paleoclimate proxies from the tropics and extra-tropics found disagreement among these reconstructions during the pre-instrumental period, which makes it challenging to identify a clear signal of internal multidecadal climate variability in the North Atlantic.

Here, we present a 237-year (1757-1994 CE) composite coral Sr/Ca record from Isla Los Testigos, Venezuela, which captures TNA SST variability over the instrumental period and beyond. Using our new coral record and published marine-based SST proxies from the tropical north Atlantic, we apply the composite-plus-scale method to reconstruct a TNA index spanning 1751-2005 CE. This reconstructed TNA correlates with the extratropical terrestrial AMO reconstruction, with the strongest correlation occurring at shorter lags in the post-industrial period and longer lags in the pre-industrial period. Preliminary analyses suggest that external forcings play a significant role in driving Atlantic multidecadal variability in our 254-year reconstruction, with anthropogenic forcings dominating during the post-industrial period. In contrast, volcanic forcings contribute to the multidecadal variability observed in the pre industrial era, as was proposed by previous studies. Our record offers a new index of decadal+ variability in the tropical Atlantic, improving assessment of the relative roles of external and internal forcings in Atlantic multidecadal variability.

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Phenotypic Diversification of Spiny Eels Across the Fragmented Freshwaters of the Afro-Tropics

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The Role of Landsliding in Steep Mountain Hydrology

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The storage and transport of water in high mountain catchments is vital to downstream water supply, yet the complexity and rugged terrain across these environments make them challenging to characterize. In active orogens such as the Himalaya, frequent landsliding due to intense rainfall and steep slopes produce high landslide frequency. Landslides represent a "hydrogeologic reset" for a hillslope by stripping vegetation, soil, and regolith, and thus altering the water balance through loss of interception and cessation of transpiration, lowering infiltration and depleting the field capacity of slope surfaces. Where landslide runout mantles hillslopes, loose, unconsolidated colluvium, produces sharp contrasts in hydraulic conductivity at the bedrock interface which acts as a hydrologic buffer, dampening the hydrologic response to storms. We examine the hydrogeology of a complex Himalayan catchment spanning hillslope to catchment scales to investigate how landslide perturbations impact runoff and infiltration dynamics in steep mountain catchments, in particular the role of landsliding in partitioning recharge into shallow and deep flow paths. We leverage a diverse geophysical, geological, hydroclimatic, and geochemical dataset to connect hillslope and catchment scale hydrogeological processes. We present two electrical resistivity tomography (ERT) transects spanning the south spur ridge of the catchment: in the native profile is dissected by shallow to moderate-sized bedrock landslides, and along the lower region where the large landslide has mantled the ridge with a thick colluvium deposit. The transects were repeated during the pre monsoon and post-monsoon to capture seasonal changes in subsurface moisture distribution. We connect hillslope to catchment scales by intersecting ERT transects with springs selected for a catchment-scale spring and stream water sampling transect for stable ∂O^{18} tracers. We identify a segregated system of water pathways, where deeper older water is sourced at higher elevations and recharge on hillslopes is largely accommodated by colluvium, which acts first as shallow storage before meeting a threshold saturation that establishes connectivity of hillslopes and rapid movement of recharge to stream.

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Coeval Porphyry Cu-Au-Mo and Iron-Oxide Copper Gold Mineralization in the Llahuín-El Espino District, Chile

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Porphyry and iron oxide-copper-gold (IOCG) deposits are typically viewed as distinct mineral systems due to their contrasting tectonomagmatic requirements, yet their spatial overlap in metallogenic transition zones suggests a shared geodynamic evolution. The Llahuin Cu-Au Mo deposit displays mixed characteristics of both porphyry and IOCG systems, involving several overprinting stages where the absolute chronology and genetic relationship between pulses remain poorly constrained. We integrate multivariate magnetite trace-element chemistry with in-situ U–Pb titanite and rutile petrochronology to resolve this complex hydrothermal history and its relationship to the neighboring El Espino IOCG system. We identified a persistent porphyry-style geochemical footprint within the magnetite that was preserved despite significant textural and chemical re-equilibration. Hydrothermal titanite (88.0–85.6 Ma) and rutile (84.8 Ma) ages anchor this porphyry mineralization to a district-scale magmatic pulse coeval with the mineralization at El Espino. These results demonstrate that porphyry and IOCG mineralization can form coevally during major tectonic reorganization as magmatic
hydrothermal fluids utilize inherited structural pathways. By characterizing these systems as temporally linked facies of an evolving arc architecture, this study highlights the role of metallogenic inheritance in the concentration of copper. Recognizing the transition between IOCG and porphyry environments as a process-driven shift in the volatile and sulfur budget within shared plumbing systems provides a robust framework for exploration in transitional magmatic-hydrothermal environments globally.

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Iron disproportionation in ultramafic silicate melts: Implications for magma ocean redox evolution

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Effects of Residential Load-Shifting Technologies and Climate Change on Bulk Power System Resource Adequacy

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Extreme temperature events have proven challenging for bulk power system operations, leading to blackouts affecting nearly 4.5 million homes in Texas during cold temperatures and over 800,000 homes in California during heatwaves. These outages are due to resource adequacy failures, characterized by an imbalance of supply and demand within the bulk power system, and anthropogenic climate change is poised to increase the risk and magnitude of such failures. To mitigate this risk, we need robust methods of accounting for weather and technology dependent changes in supply and demand at high spatial and temporal resolutions to inform power system planning and investment. Here we couple a county-level residential energy demand model with a bulk power system resource adequacy assessment and data from five global climate models to understand how synergistic effects of technologies which shift residential demand profiles and climate change compound to drive or mitigate resource adequacy failures. Residential loads can account for up to 80% of peak electricity demand with changes in end-use electrification, building envelope upgrades, and behind-the-meter solar PV plus energy storage systems beginning to shift residential electricity consumption patterns from their previous norms. We introduce an approach to model the “triplet” impact of these technologies on residential electricity demand and peak demand hours in the bulk power system.

Using a multi-layer perceptron to forecast future residential electricity demand for five representative counties under five climate models across the Western United States, we find that county level residential electricity demand can be decreased by half annually across counties and peak hour loads can be reduced by nearly 25% in counties dependent on climatology under the “triplet” effect. We will model county-level demand changes for all counties included in the Western Electricity Coordinating Council through 2050 with a regression approach to estimate bulk grid demand based on residential load changes and a

Monte-Carlo-based stochastic resource adequacy assessment to quantify expected unserved energy at differing levels of residential technology penetrations. This approach yields the first comprehensive evaluation of how emergent residential technologies and climate uncertainty will jointly challenge or bolster grid reliability over the coming decades.

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Temperature and circulation history of the Cretaceous Western Interior Seaway derived from bivalve clumped isotope geochemistry

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The Western Interior Seaway (WIS) was a vast and shallow inland sea that spanned the North American continent during the mid- to Late Cretaceous. Conditions in the WIS were complex, influenced by regional tectonic forces, global climate, eustatic sea level, and basin-scale circulation patterns. In this study, we report 117 new estimates of temperature and seawater oxygen isotope composition ($\delta^{18}O_w$) from carbonate clumped isotope paleothermometry on well-preserved marine bivalves from the WIS in the United States (U.S.) and Canada. Our samples span the Albian to Maastrichtian stages (~113–66 Ma) across modern latitudes of 25–57 ˚N. This dataset provides the first long-term and latitudinally ranging record of reconstructed water temperature and $\delta^{18}O_w$ values in the WIS. We find that, across all time periods, the U.S. portion of the seaway had minimized latitudinal temperature gradients, suggesting a dominant influence of Gulf-sourced waters. This end member was characterized as warm (23–37 ˚C) and relatively enriched (0.0–1.1‰). At Canadian latitudes, we identify a cooler (16–24 ˚C) and isotopically lighter (-4.3 to -2.5‰) Arctic-sourced water mass during the Albian and Campanian[MJ6.1]. $\delta^{18}O_w$ depletion in the Central Plains latitudes is interpreted as the influence of freshwater runoff into the basin from surrounding highlands. The resulting insights into seawater temperature and circulation provide a framework for interpreting the paleontological records and climate-sensitive facies of the WIS, as well as how paleoclimatic conditions in North America evolved compared with global deep marine records spanning the Cretaceous greenhouse climate interval.

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Clumped and Triple Oxygen Isotope Constraints on Vegetation and Water-stress across Rift landscapes of the Mid-Pliocene Lower Awash Valley, Ethiopia

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Tooth imbrication and enamel wrinkling as adaptations for herbivory in sauropodomorph dinosaurs

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Sauropodomorph dinosaurs include some of the largest animals to ever walk the Earth. They existed from the Late Triassic to the end of the Cretaceous. These animals were characterized by their massive body sizes, quadrupedal stance, long necks and tails, and a herbivorous diet. Sauropodomorphs must have consumed a large volume of vegetation to sustain their massive body sizes, so how did these animals, which did not chew their food, maximize food intake? One strategy to optimize consumption was to improve biting efficiency. This was achieved, in part, by tooth imbrication and enamel wrinkling. Tooth imbrication is defined as the teeth being rotated in their sockets and overlapping from front to back. Enamel wrinkling is the presence of varying degrees of rugosity to the surface texture of the enamel. The presence of enamel wrinkling is consistent throughout the sauropodomorph lineage, whereas tooth imbrication is present for most of the lineage but restricted mainly to animals with broad-crowned teeth (as opposed to the peg-shaped tooth forms that dominated the Cretaceous). These features have not been studied for their functional significance, so here I present findings on the functional impacts that tooth imbrication and enamel wrinkling have on obtaining vegetation.

To study the functional morphology of the sauropodomorph biting mechanism, we have created a robot, Chomper, to simulate the biting style of sauropods. Chomper is modeled after the estimated bite force and size of *Camarasaurus*. In preliminary testing we have used three-dimensional (3D) printed PLA models of a generalized sauropod tooth shape attached to the lever arms of Chomper. We made imbricated and non-imbricated models to test the effects of imbrication on biting efficacy. We compared the force required to rip through a piece of paper (a proxy for vegetation) with the two tooth orientations. We found that because imbricated teeth interlock during occlusion, imbricated teeth use a higher bite force to rip through plant matter than do non-imbricated teeth. However, non-imbricated teeth are prone to allowing the paper to slip through the teeth without tearing, indicating a worse grip. We intend to build upon these preliminary data by creating 3D tooth models from zirconia to simulate realistic tooth hardness and by adding texture to the models to test the effects of enamel wrinkling. We plan to use living plant matter to recreate the fibrous

vegetation that would have been available to these animals.

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A Pennsylvanian fish highlights mosaic character-state evolution among Paleozoic ray-finned fishes

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Neopterygians are an extremely speciose clade of ray-finned fishes that are estimated to have originated during the Carboniferous period (359–298 million years ago, Ma), but there are no unambiguous neopterygians recognized from this interval. Work in the upper Carboniferous (Gzhelian) deposits of the Appalachian Basin has revealed new specimens of *Sphaerolepis* that bear traits associated with crown neopterygians (i.e., the group containing the last common ancestor of all living neopterygians plus all of its descendants). These include serrated appendages, a coronoid process consisting of multiple ossifications, and long posterior parasphenoid stalk. Phylogenetic analyses using both Bayesian and maximum parsimony approaches fail to resolve this taxon as a neopterygian. Instead, it appears that the putative neopterygian characters of *Sphaerolepis* are instead homoplastic, represent convergent evolution of these derived traits elsewhere within ray-finned fish phylogeny. With these results, *Sphaerolepis* can now be taken to be another example of a promising crown actinopterygian candidate that instead represents the repeated evolution of synapomorphies once exclusively distributed within the neopterygian total group. Further work should focus on other putative Paleozoic neopterygians to determine whether these taxa indeed are members of this clade or if they instead represent more examples of parallel evolution.

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First report of a fossiliferous late Holocene stratigraphic record from an Amazonian forest inventory plot

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Unexpected Experimentation With Life History Strategies In Early Therians

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The marsupial-placental dichotomy refers to the intrinsic differences between extant therian mammal reproduction. Marsupials have short gestation and long lactation periods, whereas placentals have long gestation and short lactation periods. These life history traits that characterize the marsupial-placental dichotomy are reflected in the bone tissue microstructure of extant small-bodied therian postcrania. Adult marsupial hindlimb histology is characterized by near homogenous cortices composed of lamellar tissue with little/no vascularity, interpreted as a 'marsupial-like' strategy with primarily appositional postnatal bone growth to increase the diameter of the midshaft. Adult placental hindlimb histology is characterized by a tripartite 'sandwich' pattern, with a mid-cortex comprised of woven, fibrolamellar, and/or compact coarse cancellous bone, bracketed superficially (separated by a tide line) and deeply (gradational contact) by mostly avascular lamellar bone. This is interpreted as a 'placental-like' strategy with initial endosteal buttressing of the woven perinatal layer, and less periosteal apposition later to increase the diameter of the midshaft. These histological patterns have been demonstrated to preserve through fossilization at the microscopic level. This enables direct investigation of the life history traits of fossil mammals, whereas previous inferences about the evolution of mammalian reproduction have largely relied on developmental and molecular studies of living species. Here, we describe the bone histology of mammalian humeri and femora from the Upper Cretaceous (ca. 90 Ma)

Bissekty Formation of Uzbekistan, which represent some of the oldest unambiguous therian postcrania. Histological data were generated via synchrotron x-ray micro-computed tomography on 10 specimens of nine morphotypes representing mostly eutherians and one metatherian. We generated midshaft cross-sectional radiographs that were stacked and Z-projected to create virtual thin sections. Observations reveal the same growth trajectories, reflected by histological features, that have been demonstrated to correspond to reproductive strategies in extant small-bodied marsupials and placentals. Counter to our expectations, two eutherian morphotypes exhibit the ‘marsupial-like’ pattern, the metatherian morphotype exhibits the ‘placental-like’ pattern, and an adult eutherian morphotype exhibits a ‘placental-like’ pattern that has only been observed in extant juvenile placentals. Our data demonstrate that the Bissekty therians did not strictly conform to the marsupial-placental dichotomy seen today, complicating our view on the tempo and mode of therian reproductive evolution.

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Topographic diversity gradient revealed among latest Cretaceous mammals

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Modern mammalian community assembly is shaped into broad biogeographic patterns including latitudinal and topographic gradients. Although latitudinal gradients are well characterized in the Late Cretaceous of North America through continent-scale studies, topographic diversity gradients, in which biodiversity is higher within and proximal to mountain uplifts than in more distal lowlands, remain unrecognized deep in the geologic past. I hypothesize that comparing mammalian species richness between mountain-proximal and -distal sites could be used to identify this biogeographic pattern. This high-spatial-resolution study revises the taxonomy of mammals from the Hewett's Foresight local fauna, a site around 15 km southwest of the Laramide Beartooth Uplift, from the latest Cretaceous (ca. 68–66 Ma) Lance Formation of the Bighorn Basin, northwestern Wyoming, to compare updated taxonomic diversity data with the roughly coeval, mountain-distal Type Lance local fauna nearly 400 km to the east. Among multituberculates, the most speciose and abundant mammals at this time, greater species richness was found at the mountain-proximal Hewett's Foresight compared to the mountain-distal Type Lance, suggesting the presence of a topographic diversity gradient in the latest Cretaceous of western North America. Comparisons of faunal similarity across the continent indicate latitudinal and temporal patterns, consistent with previous Late Cretaceous studies. Preliminary observations of the species richness and composition of leptictids and cimolestid eutherians suggest affinities between Hewett's Foresight and the coeval Trochu assemblage, proximal to the Sevier front in Alberta. Novel topographic patterns described here suggest the emergence of Laramide uplifts were important drivers of mammalian community assembly and spatial heterogeneity in the North American Western Interior just prior to the Cretaceous-Paleogene mass extinction.

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Comparing DMSP-SSUSI Observations to Models of the Auroral Oval

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Solar Wind and Magnetospheric Drivers of Omega Band Substorm Activity

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Omega bands are mesoscale (100-1000 km) auroral structures that appear as eastward-moving poleward protrusions in the auroral oval (Fig. 1). They typically appear at dawn, or post-midnight, during periods of enhanced geomagnetic activity. Omega bands have been associated with rapidly time-varying magnetic fields at ground level, which can drive geomagnetically induced currents. These currents pose threats to transformers and other ground infrastructure, making auroral omega bands highly relevant to space weather forecasting. However, while the solar wind and magnetospheric drivers of omega bands have been previously studied, the characteristic signatures of omega band substorm events have not been identified.

In this work, we compare solar wind, magnetospheric, and geomagnetic parameters measured during general substorm activity to the same parameters measured during ~450 omega band events observed by an array of all-sky cameras in North America from 2005 to 2015. Substorm events are identified using spline fitting techniques to locate positive bays in the lower auroral electrojet. We use composite data from a suite of satellites located at L1 to determine the solar wind drivers of these events and data from satellites in geosynchronous orbit and ground stations to identify magnetospheric and geomagnetic signatures of these events. This analysis will allow us to identify the unique solar wind drivers and magnetospheric configurations associated with auroral omega band formation and improve our understanding of magnetosphere-ionosphere coupling dynamics during periods of enhanced geomagnetic activity.

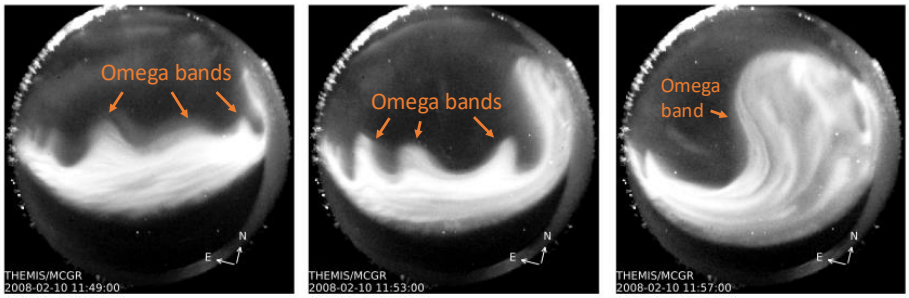

Fig. 1: Omega bands observed by the THEMIS all-sky camera in McGrath, Alaska on February 10, 2008

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Determining the boundaries of the Earth's space environment

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Contrasting behavior between H2O and Na2O during glass bead evolution in lunar gas plumes

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Volatiles have consistently played a pivotal role in the study of lunar origin and evolution. For instance, discrepancies in volatile content provide evidence for the Giant Impact hypothesis, while volatile-driven magmatism has played a decisive role in the Lunar mantle evolution and surface constructing of the Moon. Glass beads are spherical or near-spherical homogeneous substances with rounded surface formed through rapid cooling during magmatic processes. Based on the heat source of the magmatic activity, they can be classified into volcanic glass and impact glass. These materials serve as carriers that record the behavior of various volatile components during magmatic events. Recent experimental studies on moderately volatile components such as Na, K, Cu, and S in lunar volcanic orange and green glass beads have revealed that volatile behavior during magmatism is not limited to the previously assumed outgassing process. Instead, during the late stages of evolution, volatiles can enter the glass beads through ingassing, resulting in characteristic U-shaped or W-shaped concentration profiles along the diameter of the beads, which provides new insights into the behavior of volatiles on the Moon. However, it remains uncertain whether this specific behavior can be extended to all kinds of volcanic and impact glasses beads or other highly volatile components, such as H_2O and halogens (F, Cl, etc.). In this study, we analyzed the distribution of Na, H2O, and F along the diameters of four representative kinds of glass beads (green, yellow, and orange volcanic beads, as well as impact glass beads) and established diffusion models for quantitatively describing the exchange process of volatiles between the glass beads and the transient atmosphere during magmatic activity. We found that the distribution of Na along the diameters of various kinds of glass beads consistently exhibits U-shaped or W-shaped profiles, indicating that they underwent a significant ingassing process. In contrast, H_2O can display either U-shaped distributions (representing ingassing) or ∩-shaped (inverted U-shaped) profiles (representing no ingassing but degassing-only). Weak temperature dependence of H_2O vapor pressure on temperature, contrasting with strong temperature dependence of Na vapor pressure over glass beads can serve as a potential explanation. The heterogeneity of oxygen fugacities in different sources may explain the different behaviors of H_2O among different beads. The distribution of F is more scattered and difficult to characterize, leaving its behavior to be further explored in

future research. Our research extends the understanding of the degassing-ingassing processes of lunar volatiles during magmatic activity to a wider range of glass bead types and a broader suite of volatile species. Notably, we present the high-resolution H_2O concentration profiles near the edges of the Apollo volcanic and impact glass beads and identify the unique and complex physicochemical behavior of H_2O. This work provides quantitative data and a reference framework for modeling the volatile behavior and the composition of the transient atmosphere during lunar magmatic events, significantly advancing our knowledge of volatile behavior throughout the evolution of the Moon.

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Remote Sensing of Hydroclimatic Variability: Thirty Years of Urbanization Induced Surface Runoff Increases in Bangkok, Thailand

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In recent decades, climate change and rapid global urbanization have worked together to increase the frequency at which flood disasters occur. Climate change is altering established precipitation patterns, which can place increased stress on storm drainage infrastructure that has been designed for a historically static climate. Meanwhile, urbanization has largely occurred in locations that are known to be at a high risk of flooding. This is especially true in East and Southeast Asia. These regions have had the highest rate of urbanization in recent decades as well as the largest percentage of urbanization occurring in locations at a high risk of flooding. Additionally, urbanization itself can inherently increase the risk of flooding by replacing natural land cover with impermeable surfaces, leading to an increase in the amount of surface runoff for similar precipitation events. Therefore, understanding the hydrologic impacts of climate change and rapid urbanization is a key challenge for sustainable development.

Bangkok, Thailand is a low-lying coastal city that has a long history of flooding and has undergone rapid urbanization since the 1980s. By using Bangkok as a case study, this work aims to improve knowledge of surface runoff evolution patterns in climate-vulnerable, rapidly urbanizing cities. To do so, this work utilizes data from Landsat-5 and Landsat-8 and a Random Forest classification algorithm to map land use changes over the past 30 years. The land use change effect on land surface runoff is analyzed using the Soil Conservation Service (SCS) model, which relates runoff to land cover through the runoff curve number (CN). By assigning CN values to the land use classes and incorporating daily satellite based precipitation estimates, the evolution of runoff generation from 1994 to 2024 can be assessed.

We find that surface runoff in the Bangkok Metropolitan Region has continually and significantly increased throughout the study period, with larger increases in surface runoff for smaller precipitation events. This runoff increase corresponds to an increase from 11% to 32% in total land area devoted to urban land cover within the Bangkok Metropolitan Region. There was no observable trend in the occurrence of strong precipitation events, however there was an increase in interannual variability of precipitation totals beginning in 2014.

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Validating sampling and data-processing methods in high-resolution carbonate clumped isotope (Δ_{47}) sclerochronology using *Mercenaria mercenaria* for reconstructing paleoseasonality

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Paleoseasonality records are of great interest in unravelling short-term oceanic and environmental shifts to reconstruct past climate. Sclerochronological profiles measuring oxygen isotope composition in shell carbonate ($\delta^{18}O_{carb}$) have been extensively used to assess subannual variations in temperature, both in the recent and deep past. However, $\delta^{18}O_{carb}$ combines the effects of formation temperature and the oxygen isotope composition of ambient seawater ($\delta^{18}O_w$); interpretations of $\delta^{18}O_{carb}$ therefore depend on estimated $\delta^{18}O_w$ values, introducing uncertainty into the temperature values derived. Carbonate clumped isotope paleothermometry (Δ_{47}) provides $\delta^{18}O_w$-independent temperatures, but applying Δ_{47} at high-resolution has been limited by large sample-size requirements and time-intensive analysis.

In this study, we present high-resolution, Δ_{47}-derived sclerochronological profiles of temperature and $\delta^{18}O_w$ using the clam Mercenaria mercenaria, collected from aquaculture farms with monitored growth conditions along the U.S. Atlantic and Gulf coasts (Trenton, ME; Mashpee, MA; two sites in Cedar Key, FL). We compare (i) Δ_{47}-derived temperatures with instrumental seawater temperatures and (ii) Δ_{47}-derived $\delta^{18}O_w$ values with empirically-derived $\delta^{18}O_w$ based on salinity. We demonstrate that high-resolution Δ_{47} sclerochronology is possible on large taxa like Mercenaria and can identify subannual changes in temperature and $\delta^{18}O_w$, as well as growth shutoff temperatures. Modern calibration studies give us confidence in applying these methods to fossil shells and help identify the limitations of the method (e.g., inability to capture wintertime temperatures due to growth shutoffs). Our findings highlight the need to consider biological factors in Δ_{47} sclerochronology for paleoseasonality reconstructions and provide a framework for future investigations.

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Identifying Marine Organics Within Arctic Sea Spray Aerosols Using O-PTIR Spectroscopy

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The Arctic is warming 4 times faster than anywhere else in the world[1]. This effect has led to significant changes to the Arctic environment, with increasing open water having unknown effects on the production and composition of Arctic sea spray aerosols (SSA)[2,3]. Given that SSA significantly influences the Arctic climate, it is critical to understand their chemical and physical properties to better predict their impacts on the radiative budget, in addition to their contribution to cloud formation[4]. Past research shows that in the Arctic wintertime, saccharides, amino and fatty acids, and divalent cations are the common marine organics present[2]. However, uncertainty still remains regarding aerosol chemical complexity[5]. Samples collected during a year-long research expedition in the Arctic as part of the Multidisciplinary drifting Observatory for the Study of Arctic Climate (MOSAiC), will give an in depth understanding of organics present on Arctic SSA sampled during different environmental conditions. In past studies using Raman spectroscopy to analyze these aerosols, fluorescence was heavily masking the signal of the organics present. That is why Optical Photothermal Infrared (O-PTIR) Spectroscopy was used to identify the types of marine organics within MOSAiC SSA particles and observe the variability of types over these different sea ice conditions (frozen in fall, melted in July, and melting season in April). In the November case days analyzed (13th, 15th, 27th) it has been shown that there is a large variety of marine organics present but there were 3 types that occurred far more than any other ones. All but 3 stages from November case days have at least one of the 3 organics present in over 50% of particles analyzed. July 6th and 28th were analyzed, but showed no marine organics present. April 3rd is currently being analyzed to see the effects of melting season on marine organics. In order to determine what these organics are, reference organic standards that have been shown to be common in SSA particles have been purchased and will be analyzed using O-PTIR to generate a library of organics and compare to our environmental samples. This methodology will allow us to further understand what kinds of marine organics are present in Arctic SSA during different environmental conditions.

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Expanding the Toolkit: An assessment of new mollusk species for isotopic sclerochronology

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Variations in seasonal extremes play a vital role in sustaining life on Earth, making paleo-seasonality a key determinant for how organisms experience, and respond to climate change. Bivalve and gastropod shell carbonates are widely used as robust proxies for paleoenvironmental reconstruction through stable oxygen isotope ($\delta^{18}O$) sclerochronology. However, numerous environmental and endogenous factors can inhibit a species' ability to accurately record paleoclimate signals, and suitable taxa are not always available across long temporal intervals. Sampling a variety of taxa therefore improves both the range and reliability of the $\delta^{18}O$ proxy method. In this study, we perform high resolution sub-annual hand drilling of fossils from 29 species of gastropods and bivalves, to determine how effectively they record paleo-seasonality through $\delta^{18}O$ sclerochronology. We evaluate the shape of profiles, compare extrema between samples of the same formation, compare same species over time, and develop a list of viable taxa for sclerochronology. Species exhibiting rapid growth rates, moderate lifespans, and consistent isotopic extrema produce the most reliable lifetime records of paleo-seasonality. Sixteen specimens representing ten species were identified as good environmental recorders, including six previously unrecognized high-potential taxa. Expanding the range of species used in sclerochronology studies will help capture the full range of $\delta^{18}O$ variability, taking into account individual growth temperature thresholds, limits, and variation across geologic sections, with greater confidence and accuracy. This broader approach will improve our understanding of natural climate variability through time and its influence on ecological systems.

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The Influence of EDTA on Fe(III) interactions with Sodium Strong Acid Cation Exchange Resin

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Metal ions, such as aluminum, iron, magnesium, and calcium are some of the dominant constituents for most rocks and minerals on the planet. However, the most important metals for modern technologies are often trace metals such as copper, cobalt, nickel, and rare earth elements. To acquire pure forms of these trace metals, it is necessary to separate them from the corresponding mineral or rock that they have formed in. Some metals have easily exploitable properties that make their separations easier than others, such as copper, whose electrical conductivity allows it to be electroplated onto the surface of a cathode as metallic copper. Unfortunately, most metal separations are not so straightforward, especially when considering the rare earths. For that reason, cation exchange resins, which can remove metal cations from a solution, and polydentate ligands (chelators), which form multiple bonds with a single metal, have often been employed to separate metals based on chemical and physical properties. However, the regeneration cycles of cation exchange resins can require large amounts of expensive reagents for regeneration, and highly selective chelators can require complicated, multi-step synthesis. Ethylenediaminetetraacetic Acid (EDTA) is a chelator that chelates metals in a 1:1 ratio with multiple nitrogen and oxygen ligand binding sites. By separating aqueous metal ions from the metal-chelate species, it is possible to quantify the amount of chelate-bound metal and the concentration of an aqueous metal species using standard methods like Inductively Coupled Plasma-Optical Emission Spectroscopy. In this study, we investigate a sodium only regeneration as a low-impact alternative for the separation of chelated and non-chelated metals using a sodium-based cation exchange resin (HPR1100). We also seek to understand the influence of EDTA on the binding of Fe(III) with HPR1100 through sequential increases. We began by optimizing the regeneration cycle by testing different volumes (10,15,20 mL) of concentrated NaCl solutions (10%, 20%, 30% wt). Without EDTA present, the resin removes iron from solution effectively, with <5% of the initial iron remaining in solution. The addition of EDTA affects the exchange process significantly, and as expected, we see that higher concentrations of EDTA lead to less resin exchanged metal. This study establishes a baseline for the regeneration of cation exchange resins without the usage of strong acids for the separation of metal cations and follows established understanding of the influence of EDTA to Fe(III) binding.

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Quantifying U.S. Mid-Atlantic Coastal Plain Ocean Temperatures and $\delta^{18}O_{water}$ Values from the Late Miocene and Pliocene Using Molluscan Clumped Isotopes

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The mid-Pliocene Warm Period (mPWP, 3.0-3.3 Ma) was the most recent time in Earth history where global CO_2 concentrations exceeded 400 parts per million (ppm). This high greenhouse gas concentration led to an overall warmer climate with less land ice, leading to sea levels during this time that were approximately 20 meters above present day levels. Due to the similarity to our present atmosphere, the Pliocene and mPWP in particular have been viewed as relevant analogs for present-day climate and future climate change. Concerns exist over how marine life will respond to future ocean warming, making study and understanding of marine ecosystems in past greenhouse periods of great importance. Faunal studies document a regional mass extinction around Florida, the Caribbean, and the East Coast in molluscan fauna. The leading hypothesized cause for this is regional extinction is climate cooling, as this time period aligns with the first growth of northern hemisphere ice sheets. Being situated at the northern edge of this studied region, the areas of Virginia and North Carolina would be predicted to be the most impacted by cooling temperatures. However, it is difficult to predict how climate in this region would change due to the multiple factors controlling the coastal climate on the US Mid Atlantic Coastal Plain (MACP). The climate of this area is influenced by the relative position of the warm Gulf Stream current and cooler, northern-sourced Labrador Current. Further, a dynamic coastline caused by past higher/changing sea level makes it harder to predict the exact position of the Gulf Stream in the past. Thus, also understanding past shifts in the position of the Gulf Stream and its interactions with the northern-sourced Labrador Current are crucial to understanding how ocean current shifts in the future may impact the climate of the East Coast. Past efforts to constrain paleotemperatures in this region have had difficulty pinpointing accurate temperatures due to using an assumed value of $\delta^{18}O_{water}$ when calculating temperature. This study uses clumped isotope paleothermometry (Δ_{47}) to reconstruct ocean temperatures and $\delta^{18}O_{water}$ values from the Cobham Bay Member of the late Miocene Eastover Formation and all four members of the Pliocene Yorktown Formation (Sunken Meadow, Rushmere, Morgarts Beach, and Moore House Members). Data obtained from scallops such as *Chesapecten jeffersonius*, *Chesapecten madisonius,* and clams such as *Glycymeris*

americana, Mulinia sp., Panopea sp. and *Striarca centenaria* show that bottom water temperatures in this region were warmer than present day, and that $\delta^{18}O_{water}$ values were dynamic and influenced by currents throughout this time. Our new data define the baseline Mio/Pliocene conditions which allows us to understand the sensitivity of molluscan life and other biota to climate change and increasing temperatures.

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Identifying Ultra Low Frequency Waves and their Impact on the Coupling of Space Environments

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As the understanding of space environment physics advances, models and new space missions frequently target questions of coupling multiple plasma environments . The hazards of the Earth-space system need to be accurately monitored and predicted to protect the increasingly occurring space missions. Phenomena such as plasma waves and magnetic reconnection govern the ion and electron motions from the solar corona to Earth's ionosphere. Interestingly enough, ultra low frequency (ULF) waves have been shown to have an impact on the dynamics in every region of the space environment. Propagation of solar wind to Earth's bow shock, instabilities at the magnetopause, energy transport through the boundary layer, electron loss in the radiation belts, and radio signal interference in the upper ionosphere can all be associated with ULF waves. Generation and propagation of ULF waves can vary significantly from region to region, and as such have been thoroughly studied in the past. However, ULF wave propagation and transmission between different plasma systems has received less attention. Understanding how ULF waves are generated in one region, and propagated to other regions can significantly advance understanding of the coupling mechanism processes, and their impact on the dynamics of the space environment. This study will first address the impacts and generation mechanisms of ULF waves throughout the Earth's space environment. Global magnetospheric simulation results will then be used to more specifically highlight how perturbations in the magnetosphere impact the reflecting ionospheric conductances. Observations of ionospheric ULF waves will then be utilized to provide insight into how they propagate and interact with the local plasmas. This combination of methods to study ULF waves is able to highlight how ULF waves uniquely generated in separate plasma regions impact the coupling between these regions. Comparing and contrasting the model runs and observational data gives a global perspective on the propagation and impacts of ULF waves throughout the space environment.

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Constraining the Age and Thermal Structure of a Mesozoic Subduction Zone; Cedros Island, Baja California, Mexico

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Active subduction zones are unique tectonic features of Earth that are responsible for geochemical cycling and the formation and differentiation of continental crust. Understanding the thermal structure of subduction zones allows us to better constrain current models of subduction. Variations in thermal structures in subduction zones allow for different metamorphic reactions to occur at different depths and distances from the subduction trench which directly control the depth and magnitude of devolatilization and subsequent flux melting. To better understand subduction zone thermal structures, we look to the geologic record of an ancient subduction zone located on Cedros Island in Baja California, Mexico. This work focuses on the analysis of blocks of epidote-bearing and garnet-bearing hornblendites (amphibolite facies rocks with a lack of plagioclase) from serpentinite-matrix mélanges at a variety of structural levels within the subduction complex. These blocks are the highest-grade metamorphic blocks associated with subduction in this region; the subduction complex is, as a whole, dominated by blocks described as lawsonite-blueschists to lower-grade metamorphic facies. We used the zirconium–in–rutile, zirconium–in–titanite, and the Fe-Mg garnet– hornblende thermometers to constrain temperatures experienced by these hornblendites (~500–600°C). However, the zirconium-in-titanite temperatures were found to be anomalously high by ~100°C due to higher-than-expected Zr concentrations within titanite. We investigate the potential causes for these high Zr concentrations and how that relates to metamorphic conditions during the growth of titanite. To determine pressures experienced by our blocks, we used quartz-in-garnet thermobarometry and found pressures ranging from (~0.5–1.6 GPa). There is not a standardized way to analyze quartz-in-garnet thermobarometry data, as such, we analyzed how these data have been interpreted by others, and how best to analyze our results. We performed U–Pb dating of metamorphic titanite and rutile and found the age of metamorphism for these blocks to be Middle–Late Jurassic. These results not only inform us about the thermal structure of the subduction zone that formed these samples, but they also offer insights into how titanite is growing in our samples and how quartz-in-garnet thermobarometry data may be best interpreted.

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Reconstruction of Plio-Pleistocene paleoenvironment at Buck Hammock Quarry, Florida

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A local marine extinction event in the Western Atlantic over the Plio-Pleistocene has been the focus of past and ongoing research at sites across the Southeast United States, but its causes remain poorly understood, especially in eastern Florida. Buck Hammock Quarry near Orlando, Florida contains shelly sediment deposits from the Nashua Formation (~2 Ma) and a formation equivalent to the Fort Thompson Formation (~0.12 Ma), spanning the younger end of the extinction transition. Some of these deposits are older than those of previously described quarries nearby, meaning that studying Buck Hammock offers a unique opportunity to use qualitative and quantitative methods to evaluate the changing climatic and environmental conditions in eastern Florida during the early phase of the extinction.

Bulk sediment samples were collected from exposures of each formation and sieved to separate size fractions for analysis of grain size and identification of common molluscan taxa. *Mulinia* sp. and *Carolinapecten* shells from across sampled sections were drilled to produce high-resolution $\delta^{18}O_{carb}$ isotope sclerochronology profiles. These and additional *Mulinia*, *Dinocardium*, *Crassostrea*, coquina-embedded shells, and diagenetic calcite crystals were drilled for bulk Δ_{47} values to constrain $\delta^{18}O_{water}$ and water temperature of the paleoenvironment during shell formation.

Sediment size distribution, faunal composition, and isotope data suggest that during the Pleistocene, this region contained a shallow, sandy marine environment that was relatively stable but cooler than modern (modern average ≈24.5℃). Comparing *Mulinia* data from Buck Hammock and nearby Beeline Quarry demonstrates that Buck Hammock was warmer (average of ≈19.9℃ compared to ≈15.3℃) with higher $\delta^{18}O_{water}$ values (average of ≈1.3‰ compared to ≈-0.1‰) that are similar to modern (0.9-1.4‰). These trends are supported by data from all other taxa at Buck Hammock, indicating substantial regional differences in paleoclimate at the time.

This new data sheds light on local environmental conditions, enhancing our understanding of

the broad environmental and ecosystem changes that took place in Plio-Pleistocene Florida.

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The Impact of Canada's Record-Breaking Forest Fires on Surface Fluxes Across the Upper Midwest US

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As the climate warms, the frequency, size, and duration of wildfires increase. Wildfires emit particulate matter ($PM_{2.5}$), which can scatter incoming solar radiation and create diffuse radiation. Diffuse radiation has been theorized to increase carbon fluxes and evapotranspiration (ET), or the combined water flux from vegetation and soil to the atmosphere. However, whether diffuse fertilization occurs varies with location, local meteorology, and plant functional type (PFT). In 2023, the Canadian wildfire season broke records for local $PM_{2.5}$ emissions and transport across the United States (US). Through an integrative site-level and continental-scale analysis, we assess how the diffuse fertilization effect changes during extreme aerosol events between May 13 and July 3, 2023, across the upper Midwest US, and within three PFTs. Using AErosol RObotic NETwork (AERONET), AmeriFlux, and National Ecological Observatory Network (NEON) ground-based measurements, we find that there is an increase in ET, net ecosystem productivity (NEP), or both with increases in aerosol optical depth (AOD) at most sites. However, ET and NEP rarely respond similarly to AOD, and this heterogeneity within and across sites may be driven by changes in total radiation and air temperature that affect ET responses. Using Modern-Era Retrospective analysis for Research and Application (MERRA)-2 reanalysis data, along with ECOsystem Spaceborne Thermal Radiometer Experiment on Space Station (ECOSTRESS), TROPOspheric Monitoring Instrument (TROPOMI), and Soil Moisture Active Passive (SMAP) observations, we extend this analysis beyond site-level data and examine how specific wildfire smoke plumes influence surface processes.

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Ammonium uptake and regeneration across the Laurentian Great Lakes

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Nutrient loading from agricultural runoff causes eutrophication that impacts areas within all the Laurentian Great Lakes, posing a significant threat to freshwater resources. Cyanobacterial Harmful Algae Blooms (cHABs) are a prominent indicator of accelerating eutrophication within the Great Lakes. CHABs negatively impact water and habitat quality, drinking water supplies, food webs, and overall productivity of the system. Despite efforts to reduce external nutrient loading, annual cHABs persist. CHABs often persist into late summer and fall despite water column limitation of nitrogen and phosphorus, indicating that internal nutrient cycling could be supplying the bloom. Ammonium (NH_4^+) is produced from the remineralization of organic matter and is the most bioavailable form of nitrogen. Rapid uptake of NH_4^+ by microorganisms results in supply rates that are much higher than measured concentrations would suggest. Cyanobacteria have a greater affinity for NH_4^+ than most phytoplankton. Recycled ammonium may be important for sustaining cHABs, but we lack the data needed to assess this gap. This study assessed NH_4^+ uptake and regeneration rates across multiple locations in the Great Lakes in both winter and during the peak of cHAB season. Preliminary findings show that the largest rates of ammonium uptake and regeneration under light conditions were seen in Saginaw Bay, Lake Huron. The highest rates of ammonium uptake and regeneration under dark conditions were seen in the western basin of Lake Erie and Lake St. Clair, suggesting strong heterotrophic activity. We will use this data to help inform models predicting cHAB severity and toxicity.

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Between Tides and Time: Integrating Landsat and SAR to Quantify Species-Level Structural Differentiation and Climate-Driven Dynamics in Gambian Mangroves

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Mangrove ecosystems provide critical coastal protection, carbon sequestration, and fisheries support, yet they are increasingly vulnerable to climate variability and anthropogenic pressures. This study integrates Landsat optical time series (2000-2025), Sentinel-1 SAR, elevation metrics, canopy height, and field observations to quantify internal mangrove heterogeneity and climate-driven dynamics. A 15-band 2025 composite was used to map mangrove extent with a supervised Random Forest classifier (overall accuracy 99.1%, Kappa 0.98), after which unsupervised ISO-cluster analysis identified five distinct mangrove classes. Field validation across 26 sites linked these classes to ecologically meaningful assemblages: low-stature Rhizophora, tall Rhizophora, a structurally distinct Rhizophora type, Avicennia dominated stands, and mixed stands including Rhizophora, Avicennia, and Laguncularia. Classes differed consistently in spectral indices, SAR backscatter, canopy height, and distance to water, which shows hydrological and tidal zonation. Time-series analysis showed an overall greening trend but persistent class-level separation through time. We detected a system-wide NDVI decline in 2007, consistent with extreme flooding, with species-specific disturbance and recovery patterns: mixed stands showed the strongest short-term decline, Avicennia the weakest and greatest net gain, and landward Rhizophora the slowest recovery. Rainfall records (1950-2025) revealed pronounced interannual variability but an overall long-term decline (~-3.8mm/yr; ~280mm total reduction), with a structural shift toward drier conditions beginning in the late 1960s. Although rainfall partially recovered during the late 1990s and early 2000s, it remained below pre-drought levels and was strongly linked to the variability in the Atlantic Multidecadal Oscillation. These findings demonstrate that mangrove vulnerability and recovery are species- and structure-dependent, and that multi-sensor, class-resolved mapping improves the basis for targeted restoration, climate adaptation, and blue-carbon assessments in The Gambia.

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Inland Lake Wind Speed Retrieval: Integration of SWOT and CYGNSS Observations via Cluster-Specific Random Forest Models

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The accurate retrieval of wind speeds over inland lakes remains limited by the absence of coupled high-spatial resolution satellite systems and wind-wave surface algorithms designed for small lakes and having relatively short wave heights. Previously developed wind retrieval algorithms have been designed for the open ocean and are not suited to the lower wind speeds and small-scale surface roughness found in lakes. This study attempts to address this limitation by integrating L-band reflectance data from the Cyclone Global Navigation Satellite System (CYGNSS) and Ka-band backscatter observations from the Surface Water and Ocean Topography (SWOT) mission to estimate wind speeds over inland lakes. The analysis focuses on large and moderate sized inland lakes (> 325 km^2) across North America and Asia including lakes having multiple islands and complex shoreline geometry. Incorporating these diverse lake types allows us to design our study to assess radar sensitivity to heterogeneous surface conditions.

To address these diverse geographical and morphological characteristics, a K-means clustering analysis was developed using 11 variables, including lake area, depth, elongation ratio, and effective fetch, resulting in 14 different lake cluster categories. This framework allows for the development of cluster-specific geophysical model functions (GMFs) that compensate for land contamination and fetch-limited wave growth. The models are trained and validated by ERA5 reanalysis data from April 2023 to May 2025. Preliminary analysis suggests that the synergy of SWOT's high spatial resolution and CYGNSS's rapid temporal sampling may significantly enhance sensitivity to small-scale wind variations, potentially improving the retrieval accuracy in heterogeneous environments. This approach supports the generation of high-resolution inland wind products, providing critical data for lake energy balance estimation, ecohydrological modeling, and regional climate assessments.

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Assessing the Role of Northwest Indian Ocean Warming in Long-term Eastern Central India Drying

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Declining monsoon rainfall over agriculture-dependent Eastern Central India (ECI; 1901-2014) threatens regional food and water security. Observations link ECI drying to rapid Northwest Indian Ocean (NWIO) warming, which weakens monsoon circulation. However, the widely-used Community Earth System Model version 2 (CESM2) Large Ensemble fails to reproduce this drying, instead simulating increasing ECI precipitation while underestimating NWIO warming. Using the fully coupled CESM2 Large Ensemble and Pacific pacemaker experiments where realistic tropical Pacific ocean temperatures are specified, we identify dual ocean biases limiting NWIO warming: 1) a lack of El Niño intensification diminishes Pacific to-Indian Ocean heat transmission, and 2) overly deep thermocline in the southwestern Indian Ocean weakens the thermocline-SST feedback, further constraining NWIO warming. Additionally, strong thermodynamic forcing from global warming in the CESM2 Large Ensemble masks the drying effect of NWIO warming-induced monsoon weakening, resulting in ECI wetting. Addressing these model biases is critical for reliable monsoon rainfall projections.

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Tracking Seasonal and Spatial Shifts in Lake Erie Using Stable Isotope Geochemistry

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Incorporating aerosol emissions of freshwater lake harmful algal blooms (HABs) into an atmospheric model

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Cyanobacteria are prokaryotic, photosynthetic organisms that primarily compose “algal blooms” in freshwater systems. In an algal bloom event, cyanobacteria increase rapidly in population until they become visible to the naked eye. Some cyanobacteria produce toxins that can harm human and ecosystem health; these blooms are referred to as harmful algal blooms (HABs). In the Laurentian Great Lakes, analysis of lake spray aerosols (LSAs) generated via wave breaking were found to contain a significant amount of organic material from HABs. HABs emitted with LSA may have the potential to function as cloud condensation nuclei (CCN) and/or ice nucleating particles (INP). However, there is little research examining the atmospheric transport and aerosol-cloud interactions of HABs, and there are no models that simulate aerosolized HABs dispersion and transport mechanisms. Here, we incorporate HABs into an existing fully coupled atmosphere-chemistry model to simulate the effects of HABs on clouds and to assess their transport across the western Lake Erie basin. We use data from the Cyanobacteria Assessment Network’s (CyAN) cyanobacterial index (CI) product to prescribe the spatial extent of HABs in western Lake Erie. Using the existing empirical relationship for lake spray aerosol flux in a regional meteorology-chemistry model (WRF-Chem), we calculate a flux of HABs by modulating organic carbon amounts based on the CI data, which allows for the flux of organics to vary both spatially and temporally. The transport of aerosol is calculated explicitly by the model due to its Eulerian framework, and the coupled nature of the model allows for evaluation of HABs as CCN and/or INP. We use a test case in western Lake Erie at 1 km resolution during

mid-August of 2019, which corresponds to the period of maximum bloom extent for that year. Analysis of output from simulations incorporating HABs organics produces estimates of aerosolized HABs regional transport. Further, simulation results including organic material from HABs are compared to simulations without HABs to test the sensitivity of cloud formation to increased organic material in LSA in the Laurentian Great Lakes.

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Effects Of Increased Temperature And Acidification On Freshwater Nitrification Rates And Gene Expression During A Cyanobacterial Harmful Algal Bloom

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Cyanobacterial harmful algal blooms (cHABS) are a global threat to public health and aquatic ecosystem stability, and may worsen under climate change. Global temperature increases are causing surface water temperatures to rise, and elevated atmospheric CO2 is increasing dissolved inorganic carbon (DIC) concentrations in lakes and oceans ("acidification"). These altered conditions may increase the severity and frequency of cHABs, including in Western Lake Erie (WLE), a eutrophic system that experiences an annual cHAB. *Microcystis aeruginosa*, the dominant cHAB species in WLE, produces a suite of hepatotoxins known as microcystins. As the biosynthesis of these toxins is influenced by the cellular carbon (C) to nitrogen (N) ratio (C:N), changes to environmental availability of both DIC and N substrate type (e.g., ammonium, nitrate, urea) could also change toxin production. Nitrification in particular is a critical N transformation that converts ammonium into nitrate, and has been shown to decrease under acidification in marine environments. In this study we tested how temperature (current vs high) and DIC (low vs high) affected natural WLE cHAB communities in terms of toxin production, C and N uptake and metabolism, and freshwater nitrification rates. We measured nitrification rates and toxin concentrations across treatments, and using metatranscriptomics, we also evaluated changes in gene expression, including carbon concentrating mechanisms (*sbtA*, *bicA*), N uptake and assimilation (*nrt*, *amt*, *urt*, *gln*, *ntcA*), and toxin production (*mcy* gene cluster).

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Thermal Constraints on the Transition Between the Marlborough Fault System and the North Canterbury Fold and Thrust Belt, South Island, Aotearoa New Zealand

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Tracking hydrothermal processes with magnetite composition and texture at the Quebrada Blanca Cu-Mo porphyry deposit, Chile

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Quebrada Blanca (QB) is a Cu-Mo porphyry deposit within the Collahuasi District of the Eocene-Oligocene metallogenic belt of northern Chile. The deposit is hosted by several rock units: 1) Collahuasi Formation, a Paleozoic volcanic-sedimentary basement unit, 2) Paleozoic diorite that intrudes the Collahuasi Formation, 3) Paleozoic quartz monzonite-granodiorite that intrudes the Collahuasi Formation and the diorite unit (303-294 Ma) 4) pre to syn mineralization feldspar porphyry stocks (37.5-36.4 Ma), and 5) syn-mineralization hydrothermal breccias. Potassic alteration is subdivided into an assemblage of biotite and potassium feldspar, and a more pervasive phlogopite, sericite, and chlorite assemblage. Two temporally transitional alteration assemblages are identified: a magnetite-biotite alteration event, and a green-grey sericite event. Late-stage alteration includes a quartz-sericite assemblage and post-mineralization supergene argillic assemblage.

The objective of this study is to characterize the paragenesis of magnetite at QB through compositional and textural analysis of 20 thin sections from drillhole core. Magnetite in the early potassic alteration assemblage is predominantly disseminated with rare instances of acting as breccia cement, while transitional (magnettite-biotite) alteration assemblage magnetite occurs as disseminations, breccia cement, and as veins, and is often associated with chalcopyrite. Studies have found that magnetite incorporates specific minor and trace elements in predictable concentrations during precipitation from a hydrothermal fluid in porphyry deposits. We hypothesize that magnetite precipitating from later alteration assemblages will have decreasing quantities of minor and trace elements compared to early potassic stage magnetite, reflecting decreasing fluid temperature, element availability, and changing oxygen fugacity conditions that control element partitioning into magnetite. Scanning electron microscopy (SEM) was used to analyze magnetite textures and reveal coupled dissolution reprecipitation textures in transitional-stage magnetite. Electron probe microanalysis (EPMA) and laser ablation inductively coupled plasma mass spectrometry (LA-ICP-MS) will be used to determine the minor and trace element compositions of

magnetite and we will perform statistical analysis to determine how magnetite chemical composition varies across alteration assemblages. We will also use a magnetite geothermometer to estimate hydrothermal fluid temperatures to better define the deposit model.

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Using Isotope Geochemistry to Promote Ethical Sourcing of Gold via Mine Level Fingerprinting

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Sustained high gold prices have contributed to increased mining activity in some regions, including operations linked to labor exploitation and violence. In response, a growing body of research has applied geochemical and statistical approaches to help determine the provenance of gold and support efforts to reduce the presence of illegally mined conflict minerals in the supply chain as well as use the results as geochemical pathfinders for exploration. A combination of scanning electron microscopy with energy dispersive X-ray spectroscopy (SEM-EDS), electron probe microanalysis (EPMA), and laser ablation inductively coupled plasma-mass spectrometry (LA-ICP-MS) have been used to measure the trace element composition of natural gold. These data form trends in spatial distribution of trace elements in gold, but do not statistically differentiate samples at the deposit scale. Here, we use copper (^{63}Cu, ^{65}Cu), silver (^{107}Ag, ^{109}Ag), and lead (^{204}Pb, ^{206}Pb, ^{207}Pb, ^{208}Pb) isotope compositions of 300 gold samples from around the world with known provenance to test the hypothesis that isotope ratios of δ^{63}Cu, δ^{109}Ag, $^{208/204}$Pb, $^{207/204}$Pb, and $^{206/204}$Pb, can be used to fingerprint the source of gold from individual deposits.

Gold samples were dissolved via complete acid digestion, analyzed using liquid ICP-MS to determine trace element concentrations, separated using column chromatography, and analyzed using multi-collector (MC)-ICP-MS to determine stable Cu, Ag, and Pb isotope abundances. The concentration data will be compared to published LA-ICP-MS data. The isotope data will be statistically analyzed using principal component analysis (PCA) to determine if the isotope ratios are statistically unique and can be used to fingerprint the mine origin of gold. If successful, this study will aid in the development of a global library of the isotope composition of gold that has direct implications for tracing gold in the supply chain and decreasing the supply of illegally mined gold. Isotopic fingerprinting of gold in stream sediments also has the potential to be a geochemical pathfinder tool for gold exploration.

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Timing of metamorphism in the English River Subprovince through Lu–Hf garnet dating.

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Plate tectonics are a unique feature of Earth, but we know little about when plate tectonics began or what came before. The Neoarchean is of particular interest when answering this question due to the large-scale changes happening on Earth during this time. These changes, including the start of the supercontinent cycle, the Great Oxidation Event, and life becoming more complex have been linked to the potential onset of plate tectonics. To further assess this question, we need to investigate the rock record. One such place to do so is the Superior Province, which is the largest Archean craton and was assembled between 4.3 and 2.57 Ga. The Superior Province has conflicting hypotheses for how it formed including a plate tectonic model involving northward subduction of exotic terrane, and a non-plate tectonic model involving disassembly and reassembly of a proto-continent without subduction. This work focuses on the English River Subprovince (ERSP) which is a metasedimentary belt in the Western Superior Province that underwent amphibolite to granulite facies conditions. The ERSP is particularly interesting because it is a suture zone between the Winnipeg River and Uchi Subprovince and also has conflicting hypotheses for how it formed. I used U–Pb dating of zircon and Lu–Hf dating of garnet to determine the timing of magmatism and metamorphism, respectively. In a plate tectonic model, where the ERSP is an accretionary wedge, deformed during collision after subduction I would expect metamorphism to be relatively long-lived and predate magmatism. In a non-plate tectonic model, where the ERSP is a sedimentary basin deposited during disaggregation of the Superior Province proto continent and subsequently metamorphosed during reassembly I would expect metamorphism to be relatively short-lived and post-date or be synchronous with magmatism. Preliminary data suggests metamorphism occurred after magmatism which is inconsistent with a subduction setting.

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Experimental Studies of Equilibrium Triple Oxygen Isotope Fractionations in the Dissolved Inorganic Carbon System

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Triple oxygen isotope geochemistry (^{16}O, ^{17}O, and ^{18}O) of carbonate minerals is emerging as a valuable tool for paleoclimate reconstructions that provides additional information about Earth's hydroclimate of the past, supplementing traditional $^{18}O/^{16}O$ analysis ($\delta^{18}O$). Although triple oxygen isotope analysis offers valuable insights into paleoclimate studies, its application requires quantitative knowledge of the isotope fractionation relationship between carbonate minerals and their parent water, which remains poorly understood. In addition, it has been known that isotopic compositions of carbonate minerals can be affected by various species in the precipitating solution, including metal ions, or initial HCO_3^- and CO_3^{2-}. This is especially important for the carbonates that do not form under isotopic equilibrium, where an equilibrium fractionation factor between mineral and water cannot be simply applied. Therefore, it is necessary to investigate the isotope fractionations (α) not only in mineral-water systems but also between DIC species (Dissolved Inorganic Carbon: $CO_{2(aq)}$, HCO_3^-, and CO_3^{2-}) and water for a better understanding of the system. A few studies have explored the equilibrium and kinetic triple oxygen isotope fractionations in the DIC-CO_2-H_2O system theoretically and through large cluster modeling. However, to date, there are no experimental studies on equilibrium isotope fractionation factors that can verify theoretical calculations. Here, we present the first experimentally determined values of equilibrium triple oxygen isotope fractionation exponents ($\theta^{eq} = \ln(^{17}\alpha)/\ln(^{18}\alpha)$) between HCO_3^-(aq) / CO_3^{2-}(aq) and water. We conducted multiple witherite ($BaCO_3$) precipitation experiments at various temperatures (15, 25, and 40 °C) and pH range (from 8 to 12), which capture the isotopic compositions of DIC species following rapid introduction of $BaCl_2$(aq) to equilibrium DIC solutions. Our values are θ_{eq} = 0.5253-5254 for HCO_3^--H_2O, and 0.5246 for CO_3^{2-}-H_2O, which are lower than the theoretically expected values from modeling studies (θ^{eq} = 0.5259-0.5262 for HCO_3^--H_2O, and 0.5251-0.5254 for CO_3^{2-}-H_2O for 15-40 °C range). The reasons for these discrepancies are still unclear, but could be related to the uncertainties in theoretical calculations or uncertainties in experimental settings, such as the acid fractionation factor. Our study provides experimental constraints for equilibrium triple oxygen

isotope fractionation factors and can be used for a better understanding of the triple oxygen isotope system itself.

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Evaluating Miocene Temperature, Water Stress, and Hydrological Variability in the Atacama Desert with Carbonate Clumped and Triple Oxygen Isotopes

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The Atacama Desert is one of the driest places on Earth, yet we still do not fully understand the drivers or timing of its aridification. Previous studies have attributed an increase in carbonate $\delta^{18}O$ values in the mid-Miocene to the development of the Andean rain shadow and a subsequent increase in evaporation in the Atacama. However, this interpretation is not the only possible explanation because variation in carbonate $\delta^{18}O$ ($\delta^{18}O_{CO3}$) values can be a function of temperature and source water $\delta^{18}O$ composition as well as evaporation. Here, we present Δ_{47} and $\Delta'^{17}O$ data from palustrine, soil, and spring carbonates from six areas of the Central Atacama — Rio Camerones, Calama Basin, Barros Arana, El Tesoro, Barrancas Blancas, and Paso de Jama — to constrain the influences of temperature and evaporation, respectively, on the $\delta^{18}O$ record. We find that although $\delta^{18}O_{CO3}$ values in the samples increased between 10-15 Ma (from an average of -4.8 ± 0.7‰ prior to 12 Ma to -2.7 ± 1.4‰ after 12 Ma), a temporal increase in evaporative stress is insufficient to explain this pattern. $\Delta'^{17}O$ values of carbonate formation waters, which range from -58 ± 14 per meg to 20 ± 20 per meg (VSMOW) across all samples, generally increase with elevation but do not support a consistent increase in evaporative stress (decrease in $\Delta'^{17}O$ values) with time across most study sites. Temperature differences also do not fully explain the increase in $\delta^{18}O_{CO3}$ values, as taking temperature into account when reconstructing carbonate formation water $\delta^{18}O$ ($\delta^{18}O_{rfw}$) values still preserves a sharp increase between 10-15 Ma. Indeed, Δ_{47}-derived temperatures tend to vary not by time but instead by facies (e.g. 28 ± 3°C for palustrine carbonates versus 9 ± 6°C for travertines) and by elevation (11 ± 4°C for soil carbonates at

2290 m vs 26 ± 4°C at 750 m). To fully explain the variation in $\delta^{18}O_{CO3}$ values, we find that carbonates at different sites are likely recharged by precipitation with different $\delta^{18}O$ compositions. Our results thus illustrate that the observed mid-Miocene increase in $\delta^{18}O_{CO3}$ values may not have a single simple "aridification" explanation, but rather, may be a function of combined variations in hydrology, temperature, and evaporation across the landscape's stark elevation gradients.

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Obliquity Response in Bulk Sediment Geochemistry Across the Eocene-Oligocene Transition

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The Eocene-Oligocene Transition from 33.9 to 33.4 Ma is characterized by the development of an ice sheet on Antarctica, driven by decreases in atmospheric carbon dioxide. Ice sheet growth could have enhanced seasonal nutrient upwelling and oceanic carbon burial by supplying nutrients and increasing wind strength, but signals of marine productivity and carbon export in the Southern Ocean are not well constrained. We sampled marine sediment from deep-sea cores at IODP Site U1553 (52°13.44'S:166°11.49'E), located on New Zealand's Campbell Plateau at a water depth of 1221 meters, to examine changes in bulk sediment proxies across orbital cycles of ice sheet growth. Using elemental concentrations of bulk sediments from Inductively Coupled Plasma Mass Spectrometry to validate high-resolution X-ray fluorescence counts (XRF), we find that potassium (K) and barium (Ba) counts from XRF accurately represent elemental concentrations over time ($R^2 > 0.9$). Pearson correlation coefficients and principal component analysis indicate an association between K and lithogenic sediment components, such as titanium (Ti), iron (Fe), and rubidium (Rb), whereas Ba was associated with oxides, such as manganese (Mn) and zinc (Zn). We use spectral analysis and astronomical tuning to investigate the temporal relationship between K and Ba. Over 41-kyr periods, a weak inverse correlation ($r = -0.27$) between K and Ba occurs, with both increasing in concentration at the Early Oligocene Isotope Step (33.65 Ma). However, spanning the entire section (34.2 to 32.8 Ma), Ba shows a stronger in-phase relationship with obliquity ($r = 0.70$) than K ($r = 0.16$).

In bulk sediments, both Ba and K can be delivered via lithogenic sediment, but both are impacted by biogenic sediment deposition. Potassium can be absorbed onto authigenic phosphate (P) during the remineralization of organic matter, but is also lost from sediment more easily when remobilized. Barium may be delivered to sediments as barite associated with remineralizing organic matter, or reprecipitated in association with sulfate reduction. Our results support an ongoing effort to correlate carbon export to sediments with ice sheet extent and nutrient upwelling during the Eocene-Oligocene Transition. The relationship between these elements and climate will be confirmed using a future time series of bulk sediment $\delta^{18}O$, while future Total Organic Carbon measurements will assist in identifying higher intervals of greater carbon export.

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Miocene megaflora of Cuenca Basin in Ecuador: composition and fossil plant descriptions

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The Cuenca Basin in Ecuador is an intermontane basin linked to uplift of the northern Andes, that preserves a fossil-rich transitional sequence of shallow marine to coastal fluvial deposits of Miocene age. These sediments are interpreted to have accumulated in an embayment along the Pacific margin or as an intermontane depression connected to Proto-Amazonia, providing insight into lowland tropical communities during the Miocene. Within this sequence, the middle Miocene Azogues Formation has yielded over 400 plant fossils from more than 40 localities, including leaves and numerous reproductive structures that are currently housed at the University of Michigan Museum of Paleontology. These specimens were previously analyzed but with minimal descriptions and were tentatively interpreted as resembling a tropical dry forest. This study aims to systematically describe the megaflora using a morphotype system based on leaf architecture, and to investigate their botanical affinities. Preliminary assessments have allowed the identification of plant lineages common in lowland tropical forests, including leaves of *Apeiba* (Malvaceae), and *Brosimum* (Moraceae), and disseminules of *Triplaris* (Polygonaceae), *Tachigali* (Fabaceae), and previously described *Loxopterygium laplayense* (Anacardiaceae). Understanding the taxonomic composition and relative abundance of Cuenca megaflora provides a better approach to reconstructing ancient ecosystems of Miocene Ecuador.

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Kirkiaceous fruits from the Late Cretaceous of James Ross Island, Antarctica

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Exploring Leaf Hydraulics of Campanian Antarctic Conifers

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Marine tropical fossil fishes throughout the Cenozoic of the Indo-West Pacific: a paleontological perspective

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Insights into dietary niche partitioning among archaic ungulates from the early Paleocene of the Denver Basin revealed by dental microwear textures

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Archaic ungulates (‘condylarths’) were among the most speciose groups of mammals following the Cretaceous-Paleogene mass extinction in North America. Exceptionally preserved fossil archaic ungulates, including skulls and jaws, have been recovered from Corral Bluffs of the Denver Formation in the Denver Basin, Colorado. Specimens in Corral Bluffs are tightly linked to mega- and palynoflora fossil records in a well-resolved chronostratigraphic framework, permitting comparisons between macroevolutionary and ecological trends among mammals and plants in the first ca. 1 Ma of the Paleocene. Additional fossil localities, located in the northern Denver Basin (West Bijou Creek–1 and Alexander locality), have revealed well-preserved maxillae and mandibles. Previous work has emphasized resolving the taxonomic and phylogenetic affinities of these animals, but fewer studies have focused on paleoecology, specifically that of diet, due to similar molar morphologies across condylarthran subgroups. Here, we use dental microwear texture analysis (DMTA), an approach independent of gross morphology that uses microscopic pits and scratches to assess the properties of foods an animal was eating in its final days. We present DMTA of ten individuals spanning five genera: *Baioconodon denverensis*, *Carsioptychus coarctatus*, *Ectoconus ditrigonus*, *Eoconodon coryphaeus*, and *Ampliconus browni*. Between specimens sampled in this study, three categories are apparent: (1) textures presenting far more scratches than pits, represented by *Baioconodon*, *Carsioptychus*, and one individual of *Ampliconus*; (2) textures presenting far more pits than scratches, represented by *Ectoconus* and one individual of *Eoconodon*; and (3) textures presenting similar amounts of scratches and pits, represented by one individual of *Ampliconus* and one individual of *Eoconodon*. *Baioconodon* resembles the DMTs observed in extant herbivores; it is likely that

Baioconodon consumed a range of soft to tough foods such as leaves or nuts. *Carsioptychus* resembles the DMTs observed in extant folivores, frugivores, and omnivores; *Carsioptychus* may have been omnivorous with a preference for leaves or fruits. *Ectoconus* resembles the DMTs of extant durophagous and carnivorous animals; *Ectoconus* was likely omnivorous with a preference for carnivory. *Eoconodon* resembles the DMTs observed in extant carnivorous, insectivorous, and herbivorous animals; *Eoconodon* was likely a true omnivore exhibiting no preference for specific foods. *Ampliconus* resembles the DMTs of extant folivores and herbivores; however, the presence of pits suggests *Ampliconus* was an omnivore with a preference for plants. These findings (Fig. 1) can be used alongside gross tooth morphology to infer archaic ungulate diets and their potential relationship to plant community changes through the early Paleocene in the Denver Basin.

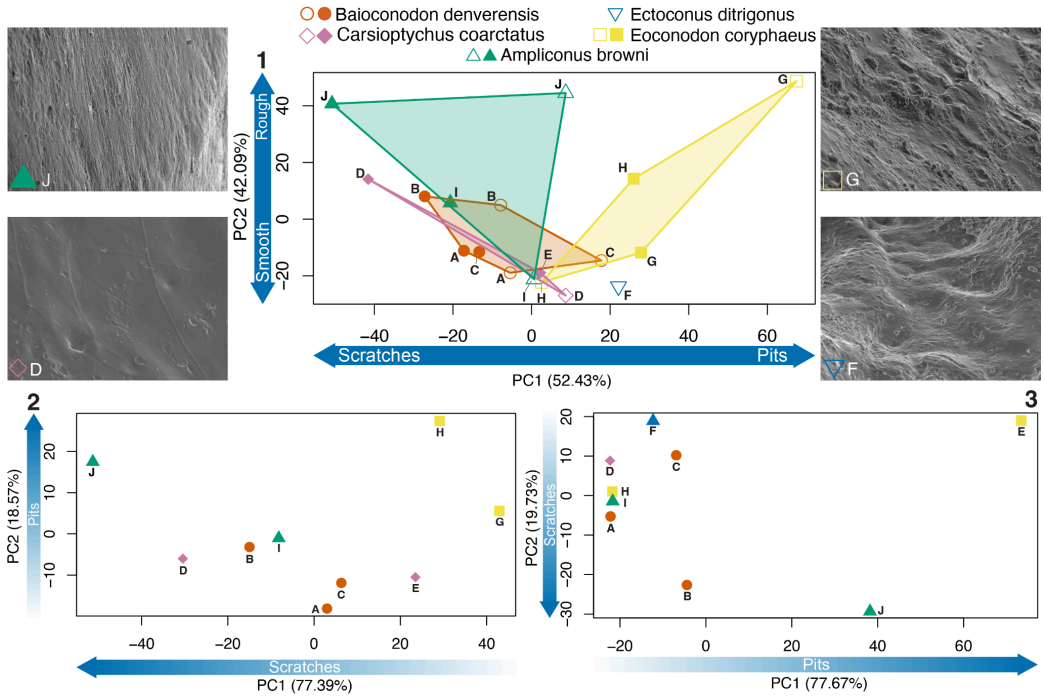

Figure 1: PCA of para- and protocones of taxa in the study. *Carsioptychus coarctatus* (UCM 101756) and *Ectoconus ditrigonus* (UCM 44266) have been excluded due to anomalous textures. **1**: paracones and protocones included. **2**: paracones included, protocones excluded. **3**: protocones included, paracone excluded. Open symbol = paracone; closed symbol = protocone. A = *Baioconodon denverensis* (DMNH EPV.2500); B = *Baioconodon denverensis* (UCM 34937); C = *Baioconodon denverensis* (UCM 34171); D = *Carsioptychus coarctatus* (DMNH EPV.145450); E = *Carsioptychus coarctatus* (UCM 101756); F = *Ectoconus ditrigonus* (UCM 44266); G = *Eoconodon coryphaeus* (DMNH EPV.130972); H = *Eoconodon coryphaeus* (DMNH EPV.130976); I = *Ampliconus browni* (UCM 35079); J = *Ampliconus browni* (UCM 48750).

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A Multi-Spacecraft L1 Solar Wind Pipeline with Causality-Enforcing Propagation for SWMF Boundary Conditions

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The NASA High Resolution OMNI (HRO) dataset is the community standard for propagated solar wind observations, but its single-source selection in 3-hour blocks, limited multi spacecraft cross-validation, and handling of out-of-sequence arrivals by averaging can introduce artifacts into upstream boundary conditions for magnetospheric simulations. Additionally, DSCOVR plasma data in HRO have not been updated past 2019, and the dataset has relied primarily on Wind since 2020. We present an open-source Python pipeline that simultaneously ingests 1-minute data from ACE, DSCOVR, and Wind, including current DSCOVR plasma from NOAA NGDC, and combines them through minute-by-minute intelligent source selection. Multi-layered quality checks cross-validate between spacecraft to flag bad data before an adaptive priority hierarchy merges the best available observations, with continuity guards to prevent artifacts at source transitions. Ballistic propagation to configurable magnetospheric boundaries enforces strict causality by removing overtaken parcels, ensuring physically self-consistent shock fronts.

We demonstrate the pipeline on May 2024 solar wind data encompassing the historic Gannon storm sequence and show improved continuity, reduced spurious transients, and cleaner shock propagation relative to OMNI. The pipeline and its output are being developed as a community service for SWMF/BATS-R-US users requiring reliable upstream boundary conditions.

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Meso-scale Polar Cap Flows and their Impact on Polar Cap Patch Evolution

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The Earth's ionosphere is subject to driving from the solar wind, which is responsible for redistributing mass and energy. In the polar regions, solar wind driving propagates density in predictable large-scale patterns. One example of density structures in the polar cap ionosphere are polar cap patches. These are regions of enhanced electron density in the F region ionosphere, at least twice as dense as surrounding plasma that give off an optical emission called airglow as the enhanced density recombines to neutrals. On a large-scale, polar cap patch behavior is generally understood to follow the large-scale anti-sunward convection in a southward IMF. Although meso-scale convection is known to exist, it's evolution and impact on the patches are not as well understood. Characterizing the lifetime, structure, and effect of mesoscale ionospheric flows will provide context as to how they might impact and drive polar cap patch propagation and evolution. Additionally, polar cap patches can disrupt GPS signals, so characterization of polar cap patches will not only provide insight into the structure, dynamics, and coupling process of the ionosphere and magnetosphere, but also the potential space weather impacts.

In this study, we present the two events that show the evolution of polar cap patches in relation to the mesoscale ionospheric flow structures. We compare optical airglow emissions using redline optical data from the OMTI All-Sky-Imager located at Resolute Bay and Eureka, Canada, and high-resolution convection maps from SuperDARN radar data. We find that mesoscale flow channels exist within the large-scale ionospheric flow pattern, and that these channels are collocated with the polar cap patches. In general, the mesoscale flow channels change on a smaller spatial and temporal scales than the large-scale ionospheric flows. The polar cap patches respond to changes in the direction and strength of the mesoscale flow channels contained in the large-scale ionosphere flow patterns, often slowing down and fading soon after the mesoscale flows cease or changing direction as other flow channels appear. These results show that polar cap density propagation often involves meso

scale flow channels, and that polar cap patch behavior is closely tied to mesoscale flow channels.

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Reconnection potential via Null-based Extraction and Utilization System (RECONEXUS) - A Novel Approach to Evaluating Dayside Reconnection in MHD Models

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Shall We Split? Foraminiferal Reproductive Regime Shifts in Response to Environmental Instability During the Little Ice Age in Santa Barbara Basin, California.

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The Santa Barbara Basin has provided numerous high-quality records of climate change due to its unique high sedimentation rates, which enable researchers to examine climate change on an annual basis. Kahanamoku-Meyer et al. (2025) hypothesized that the relative frequency of megalospheric to microspheric *Bolivina argentea* was a product of environmental variability. When environmental conditions were stable and preferred by *B. argentea,* the benthic foraminifera reproduced asexually, which is the quickest way to increase population; however, when conditions were unfavorable *B. argentea* reproduced sexually to expand the gene pool. Benthic foraminifera were counted from samples (grain size>150 μm) spanning 1500 to 1900 CE from SPR0901-02KC (34°16.80N, 120°2.30W, 588 m water depth), which was sampled at 0.5 cm intervals. In addition, the megalospheric form of *B. argentea,* which is produced assexually, was distinguished from the microspheric form that is produced sexually, and their relative abundance was calculated. This assemblage data is compared with published records of bottom-water oxygenation (metal enrichment), marine productivity (fish-scale accumulation rates), and El Niño-Southern Oscillation variability (Ti delivered by river runoff).

Here we show that during an interval (1600-1750 CE) of low bottom water oxygen (Wang et al, 2021), the absolute abundance of *Bolivinids* was high and the relative abundance of microspheric (sexual) to megalospheric (asexual) *B. argentea* was low. Intervals when the relative abundance of microspheric (sexual) to megalospheric (asexual) *B. argentea* was high are associated with increased relative abundance of anchovy, greater ENSO variability, and high relative abundance of *Nonionella stella*. The results support the hypothesis that environmental variability controls the reproductive regime of *B. argentea.*

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Compound-specific nitrogen isotope composition of a meromictic freshwater strain of *Synechococcus*

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Nitrogen (N) is an essential nutrient for life and is required for photosynthetic organisms to build the constituents of light-capturing chlorophyll pigments. Stable porphyrin rings within the pigment molecules allow chlorophyll degradation products to maintain their initial N isotope composition through time, while general biomass is otherwise altered. This makes chloropigments and their derivatives important proxies for understanding past primary productivity and nutrient cycling in aquatic systems. Previous research has shown that distinct taxonomic patterns emerge between freshwater (median: -10.3 ± 2.6‰) and marine (median: 0.2 ± 2.5‰) cyanobacteria regarding the offset of N isotope compositions between total biomass and chlorophyll *a* ($_{por} = N_{biomass} - N_{chlorophyll}$ ε δ^{15} δ^{15}). Constraining environmental patterns of ε_{por} will provide further insight into phytoplankton productivity and nutrient cycling encoded in the rock record. In this study, we are investigating the magnitude of $_{por}\varepsilon$ in a strain of the cyanobacteria *Synechococcus* isolated near the chemocline of the oligotrophic, meromictic Green Lake (Fayetteville, NY). The strain was grown in batch cultures and sampled at various stages of growth for total biomass and chlorophyll *a* δ^{15}N isotope measurements. Results will show whether the culture exhibits ε_{por} values consistent with those of previously studied freshwater cyanobacteria, which preferentially assimilate ^{15}N during chlorophyll *a* biosynthesis relative to biomass.