MGU

Michigan Geophysical Union

Annual Symposium Program Booklet

April 5th, 2024

The University of Michigan

Welcome to the 20th annual Michigan Geophysical Union Research Symposium!

Once again, we welcome everyone to MGU's annual meeting! This one is extraordinary because it is the 20th anniversary of MGU! While our Google Drive only goes back to 2018, we know MGU has grown and changed significantly over the years. This year alone we had 70 abstracts submitted from 5 different departments and across 11 subdisciplines! We have also continued to lean into the interdisciplinary nature of MGU, by having two chairs, one from EES and one from CLaSP, and a committee representing many of the subdisciplines.

This year we are welcoming several changes to the recent format of MGU. We moved from the Michigan League, down the street to the BSB, and NUB. This allowed us a lot of flexibility in our planning that we had never had before! Being in the BSB adjacent to the Natural History Museum allows us to make MGU more of a public event and bring awareness to the amazing science going on at Michigan! This year we decided to highlight undergraduates with talks, many of whom are presenting their senior theses. We were also able to implement a post-MGU reception in NUB, which we did not have previously. We hope this is a space to continue connecting with others from across the University and learn more about how our science is interconnected. With these changes in mind, we truly appreciate our organizing committee and faculty advisors for supporting these changes, thinking quickly when new issues arose, and brainstorming how to best implement everything.

We owe any and all successes of MGU to the people involved, from our presenters and their willingness to present their extraordinary science, our organizing committee and faculty advisors for planning this, our expert judges, and, of course, the EES and CLaSP departments. Most importantly, we thank the attendees for supporting our presenters!

We can only imagine what will happen in the next 20 years, but we hope that MGU will continue to have a place at Michigan and that it will continue growing and evolving with future students!

-Daeun Lee (EES) and Elizabeth Wraback (CLaSP)

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EVENT SCHEDULE

MORNING

REGISTRATION OPEN – (10:30 AM-11:00 AM) – BSB

POSTER SESSION – (11:00 AM-12:30 PM) – BSB

A01 - *Assessing substrate vs. light limitation of photochemical production of H_2O_2 in arctic surface waters,* **Nathan Laframboise**, p.29
A02 - *Archean terrestrialization of the biosphere and impacts on marine ecosystems,* **Cecilia Howard**, p.23
A03 - *Oxygenation and Alkalinity Drive the Lacustrine Nitrogen Isotope Record 3.2 Billion Years Ago,* **Diana Velazquez**, p.63
A04 - *Controls On Hydrogen Peroxide In Lake Erie,* **Emma Johnson**, p.25
A05 - *C and N Cycling at Willow Pond to Determine Viability for Mnomen Reintroduction,* **Dawson Trotman**, p.61
A06 - *Tracking N and C Uptake from Urea in Microcystis Strains,* **Hadley VandeVusse**, p.62
A07 - *Assessing Water Chemistry Dynamics And Environmental Suitability For Mnomen Reintroduction,* **Kohler Briggs**, p.6
A08 - *Isolating Microcystis aeruginosa from Western Lake Erie,* **Ryann Jibson**, p.24
A09 - *Assessing the Degree of Lake Sedimentary Organic Matter Degradation Under Different Water Column Oxygenation Levels,* **Sean Henry**, p.21
A10 - *Effects Of Microbial Iron Reduction On Archean Banded Iron Formations,* **Theresa Casselman**, p.8
A11 - *Chemical Composition and Sources of Sea Salt Aerosols over the Central Arctic Ocean: Single-Particle Measurements from a Year-Long Polar Research Expedition,* **Tiantian Zhu**, p.59
A12 - *Using Neon And Ecostress To Understand The Role Of Diffuse Light On Vegetation,* **E Schwartz**, p.52
A13 - *Characterization of Individual Carbon-Containing Atmospheric Particles Collected in Wintertime Fairbanks, Alaska,* **Monica Mashkevich**, p.38
A14 - *Oxygenated Organic Volatile Compound Measurements In An Arctic Oilfield,* **Anjali Donnelly**, p.13
A15 - *Morphology and Chemical Composition of Individual Atmospheric Sea Salt Particles during MOSAiC,* **Cheuk Yin Chadwin Ng**, p.42
A16 - *Detroit Watershed and Coastal Georgia Precipitation and Streamflow Spatial Analysis in Correlation to Flooding Events and Property Damages,* **Caitlyn Feldpausch**, p.16
A17 - *Quantifying the Impacts of Atmospheric Rivers on Snowfall Over Central Greenland,* **Alanna Wedum**, p.65

A18 - *Impacts of Atmospheric Rivers on Snow Microphysics,* **Jack Richter**, p.47
A19 - *Analyzing Spatial-Temporal Atmospheric Effects Of Lightning-Produced Nitrogen Dioxide,* **Derek Scholten**, p.50
A20 - *Coupled Fluid-Kinetic Simulations of Dipolarization Fronts in Mercury's Nightside Magnetosphere,* **Alexander Cushen**, p.12
A21 - *Investigating and Correcting Singular Behavior in Physics-Based Auoral Models,* **Ari Gottesman**, p.20
A22 - *Thermal State and Solidification Regime of the Sulfur-Rich Martian Core: Insights from the Melting Behavior of FeNi-S at High Pressures,* **Marley Gonzales**, p.18
A23 - *Validating Space Weather Forecasts: An Analysis of Historical Solar Wind Variations Using the AWSoM Model,* **Alex Zhang**, p.66
A24 - *Temperature reconstruction of the Western Interior Seaway using carbonate clumped paleothermometry,* **Adriana Brown**, p.7
A25 - *Reconstructing Last Interglacial Climate and Ocean Dynamics off of Coastal Massachusetts,* **Alex Quizon**, p.46
A26 - *Carbonate clumped isotope (Δ_{47}) temperature reconstructions from the Plio-Pleistocene Florida Platform: Assessment of a regional extinction event,* **Lucas Gomes**, p.17
A27 - *Evaluating 'Nutrient-Like' Upwelling Proxies in Galápagos Corals,* **Cameron Tripp**, p.60
A28 - *Reconstructing Paleocene/Eocene atmospheric carbon isotopic composition with terrestrial organic matter from the Hoback Basin, Wyoming,* **Katarina Keating**, p.26
A29 - *Helmholtz-Magnetometer Ensemble Calibration for Space Environments,* **Cole Dorman**, p.15
A30 - *Perspectives On Cop 28: Global Stocktake And Climate Action,* **Ananyo Bhattacharya**, p.4

LUNCH – (12:30 PM - 1:15 PM) – NUB 2540

AFTERNOON

LIVE TALKS – (1:15 PM - 2:40 PM) – NUB 1544

1:15-1:20 - Opening Remarks
1:20-1:28 - *Sclerochronological Measurements and Growth Data of Pleistocene Scallops*, **Jonathan Portinga,** p.45
1:29-1:37 - *Investigating and Correcting Singular Behavior in Physics-Based Auoral Models*, **Ari Gottesman,** p.20
1:38-1:46 - *Differences in the mineralogy and morphology of Eocene Green River Basin stromatolites across paleolake stages,* **Zach Loveall,** p.34
1:47-1:55 - *Comparative Analysis Of Urban Green Space Distribution Across Multiple United States Metropolitan Statistical Areas From 2013 To 2022*, **Miriam Bartleson,** p.2

1:56-2:04 - *Do changes in spawning season of Chione sp. factor into survivorship through the Plio-Pleistocene molluscan extinction?*, **Eric Waters,** p.64

2:05-2:13 - *Validating Space Weather Forecasts: An Analysis of Historical Solar Wind Variations Using the AWSoM Model*, **Alex Zhang,** p.66

2:14-2:22 - *Collection and Characterization of Raman Spectra of Individual Arctic Sea Spray Aerosol Particles*, **Hailey Kempf,** p.28

2:23-2:31 - *Correlating the South American Low Level Jet and Precipitation Totals in Central Argentina*, **Katarina Cavins,** p.9

BREAK / REGISTRATION OPEN – (2:30 PM-2:40 PM) – BSB

POSTER SESSION – (2:40 PM-4:30 PM) – BSB

B01 - *Formation Of The El Laco Iron Oxide-Apatite Deposit, Chile, Via Precipitation From A Co2 Bearing Fe-Cl-S-Rich Salt Melt,* **Ally Murray**, p.41

B02 - *Timing of monazite formation in the Colombian emerald deposits,* **Andres Felipe Gonzalez Duran**, p.19

B03 - *Analysis of tectonic activity from modern thermobarometry during the late Archean in the English River Subprovince, Ontario Canada,* **Hannah Schroeder**, p.51

B04 - *High-Pressure Melting Behavior of Potassium Carbonate (K_2CO_3) in Subducted Slabs: Implication for Deep Carbon Cycle,* **Jiaqi Lu**, p.35

B05 - *Radiogenic Heat Production Of Metapelites: A Case Study From The Precambrian Basement Of The Ivanpah And Southern Mccullough Mountain Ranges,* **Julisan Street**, p.55

B06 - *The Role Of Dike Transport During Differentiation And Segregation Of A 2-Km High-SiO_2 (>76 wt%) Leucogranite Cap In The Zoned Spirit Mountain Granite, Southern Nevada,* **Mackenzie Taylor**, p.57

B07 - *Jupiter's Energetic Aurora Unraveled By Juno Spacecraft,* **Ananyo Bhattacharya**, p.5

B08 - *[withdrawn],* **Connor DiMarco**

B09 - *Resolving Lake Erie's Evaporation Estimates Using Stable Isotopes,* **Jada Langston**, p.30

B10 - *Investigating Hydroclimate Changes in Eastern Africa: A Focus on the Miocene,* **Daeun Lee**, p.31

B11 - *Evaluating the reproducibility of coral Sr/Ca in the slow-growing Siderastrea siderea among colonies at Los Testigos Island, Venezuela,* **Tanuputri Joelle**, p.56

B12 - *Coral-based reconstruction of climate variability in the Western Indian Ocean,* **Yunfan Chen**, p.10

B13 - *Decadal Variability of Tropical North Atlantic Sea Surface Temperatures based on Venezuela Coral Geochemistry (1869-1994),* **Flora Luo**, p.36

B14 - *Methods And Analysis Of Tusk-Derived Life Histories Of Male And Female Mammoths From Chukotka,* **Ethan Shirley**, p.53

B15 - *Fruits For Understanding Morphological Change Of Araceae In The Fossil Record,* **Jeronimo Morales Toledo**, p.40

B16 - *The Utility of AI Tools in Teaching Earth and Space Science,* **Tom Palmer**, p.44

B17 - *Characterizing ENSO Teleconnections Impacts on Gross Primary Productivity across CMIP6 Earth System Models,* **Maria Salazar**, p.48

B18 - *Finding Correlations Between Severe Weather Stability Indices To Predict Tornadoes,* **Finnegan Steenhagen**, p.54

B19 - *Satellite NO_2 Trends Across the US and their Relationship to Land Cover Type,* **Kate Bartlett**, p.3

B20 - *Halogenated Volatile Organic Compounds In An Arctic Oilfield,* **Claire Thomson**, p.58

B21 - *Genomic Insights Into Carbon Uptake Strategies Of Microcystis: Implications For Toxin Production And Bloom Formation In Western Lake Erie,* **Helena Nitschky**, p.43

B22 - *The Effects of CO_2, Temperature and Nutrients on Microcystis Growth and Toxin Production,* **Marlayna MacKay**, p.37

B23 - *Arctic Deltas: A Proxy For Martian Deltas?,* **Doni Anderson**, p.1

B24 - *Using Ais Data To Determine The Location Of Ocean Bottom Fiber Optic Cables,* **Marcelle Collares**, p.11

B25 - *Multi-Scale Assessment Of Layered Rocks For Enhanced Rock Strength Estimation Models,* **Sally Keating**, p.27

B26 - *Investigating Connections Between Tectonics, Hydroclimate, and Fauna in Early-Cenozoic Northern Basin and Range via Stable Isotopes,* **Tara Lonsdorf**, p.33

B27 - *Investigation of Seismic Velocity Changes in Mexico City with Seismic Interferometry and Distributed Acoustic Sensing,* **Yang Li**, p.32

B28 - *Understanding the Rupture Process of the Mw 7.6 2022 Michoacán Earthquake with Distributed Acoustic Sensing,* **Yaolin Miao**, p.39

B29 - *Spatiotemporal B-Value Evolution In Geothermal Induced Earthquake Sequences,* **Matthew Salinas**, p.49

B30 - *Effect Of Carbonate Melts On The Deep Carbon Cycle,* **Siyuan He**, p.22

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

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ARCTIC DELTAS: A PROXY FOR MARTIAN DELTAS?

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Mars' paleoclimate is a hotly debated topic. Ancient Martian deltas might help us better understand the history of Mars' climate. Arctic deltas on Earth provide insights about how ice cover affects depositional patterns, potentially holding clues to determining if Martian deltas may have formed under the influence of ice. We used numerical models simulating Arctic deltas to examine how the presence and thickness of ice impacted delta stratigraphy. We found that offshore deposition increased with the presence of ice, which aligned with findings of previous studies; however, as ice thickness increased, offshore deposition decreased. The fraction of sand present throughout the subaqueous regions followed the same pattern, increasing with the presence of ice but decreasing with increasing ice thickness. High sand fractions were more prevalent throughout the main (subaerial) delta regions where sediments were likely deposited in inactive channels. 3m-thick ice models and 0.5m-thick ice models had lower sand fractions than no ice and 4.5m-thick ice models throughout the main delta region, with 3m-thick-ice models having the lowest average sand fraction. When comparing deltas with no ice and deltas with 4.5m-thick-ice, the deltas were similar in terms of depositional area and sand fraction throughout the whole domain. However, 4.5m ice models showed signs of overbank sand deposition and relatively fewer channels while deltas with no ice had channel deposits reaching farther toward the shoreline. Most of our findings correspond closely to the dynamics associated with different conditions. We found that overbank sand deposits were typically found only in ice-covered deltas, likely due to increased flooding, while deltas with no ice present consistently had more channel fills, likely associated with their higher channel mobility in the absence of ice. Future work will apply these findings to martian delta stratigraphies to determine whether Martian deltas may have formed in an icy environment.

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COMPARATIVE ANALYSIS OF URBAN GREEN SPACE DISTRIBUTION ACROSS MULTIPLE UNITED STATES METROPOLITAN STATISTICAL AREAS FROM 2013 TO 2022

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Access to green space in urban areas contributes positively to human health, with documented benefits such as reducing risks of psychiatric disorders, as well as reducing heat exposure by contributing to urban heat island mitigation through evapotranspirative cooling. However, not all green space is distributed equally; studies have shown that socioeconomic status factors such as race and median household income are strong predictors of green space presence. Thus, marginalized communities may not have access to green space benefits. The present study maps and compares green space distribution across multiple metropolitan statistical areas from 2013-2022 to understand socioeconomic status (median household income, race, age, crime rates, and low birth weight rates) and environmental factors (precipitation and temperature) that impact or are impacted by green space distribution. Urban green space was mapped using Landsat 8 and calculating green vegetation fraction (GVF) with Landsat green vegetation fraction. Socioeconomic status factor data was retrieved from the ACS 2019 5-year estimate and county crime and birth weight reports, and environmental data was retrieved from Daymet. Air temperature is expected to be lower over census tracts with higher GVF. Higher precipitation is expected to be associated with census tracts with higher GVF. Census tracts with higher percent Black population, higher average age, lower median household income, lower crime rates, and high birth weights are expected to have lower GVF. Analysis of the relationship between green space distribution and socioeconomic status and environmental factors across individual MSAs, as well as across different MSAs, will provide insight on the spatial patterns and relationships between these variables. The results of this study will identify cities that distribute green space more equally across census tracts, which can be further investigated and used as a model for improving green space access for marginalized communities.

Satellite NO_2 Trends Across the US and their Relationship to Land Cover Type

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Nitrogen dioxide (NO_2) is a highly reactive air pollutant that affects human health and leads to the formation of aerosols and ozone in the atmosphere. Nitrogen oxide is emitted from a combination of natural (e.g., soils, lightning) and anthropogenic (e.g., combustion) sources, and anthropogenic emission controls have significantly reduced the tropospheric column density of NO_2 over the past two decades. However, the extent to which natural sources contribute to the column density is not fully understood, and the natural sources can be influenced by changing climate. Here we use data from NASA's Ozone Monitoring Instrument (OMI) to evaluate the interannual variability and trends in the tropospheric column density of NO_2 over the past two decades over four different regions across the United States (the Northeast, Southeast, Midwest and West Coast). NO_2 column trends reveal an increase in the past 2-3 years, particularly in the western and southeast regions of the US. This change can be attributed to wildfire emissions, as the frequency of wildfires has increased significantly over the last few years. Additionally, we evaluate NO2 column changes with land cover type to understand the role of biogenic soil NOx and enhancements due to fertilizer application.

PERSPECTIVES ON COP 28: GLOBAL STOCKTAKE AND CLIMATE ACTION

Bhattacharya, Ananyo[1], Wells, Sarah[2,3], Eaheart, Meredith[4], Friedman-Heiman, Aaron[3,5], Hammerslough, Emily[6], Kennedy, Jacob[3,5], Lecha, Sebastian[4], Martinez, Ashley[3,5], Nawawi, Shuhaib[4], Neuenfeldt, Haley[2,3], Phalen, Sarah[2], Renteria, Francisco[2,3], Revolinsky, Ryan[4], Salamey, Zoe[2], Stavros, Alexandra[2], Wagner, Carmen[2,4] , Basu, Avik[3]

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The 28th United Nations Framework Convention on Climate Change (UNFCCC) Conference of Parties (COP) was hosted in Dubai, UAE from November 30 to December 13, 2023. It saw the conclusion of the first Global Stocktake i.e. evaluation of progress on the goals set by nations with regard to reduction of greenhouse gas emissions. The outcomes of the Stocktake will guide the national actors to formulate new goals, and policies to meet greenhouse gas emission reduction, and address technical and social challenges in mitigation, adaptation, representation of indigenous and underrepresented groups in climate action. The University of Michigan delegation participated in COP 28 as a part Research and Independent Non-Governmental Organization observers. The delegates interacted with various stakeholders associated with climate action, and impacts of climate change. They also had the opportunity to volunteer with UNFCCC for events focused on indigenous knowledge for climate adaptation. These experiences have played an important role for personal and professional growth of the delegation members. We provide an analysis of key takeaways from COP 28 in context of Global Stocktake, climate finance, and adaptation.

JUPITER'S ENERGETIC AURORA UNRAVELED BY JUNO SPACECRAFT

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Jupiter's polar regions experience changes in atmospheric temperature, ion and neutral densities due to precipitation of energetic protons and electrons (10-100 keV) in the Jovian ionosphere. Jupiter's strong magnetosphere directs these particles to high latitude regions, causing electron impact ionization of ionospheric plasma. In a high collisional plasma environment, these processes can contribute to plasma absorption in the microwave environment as evident from the Juno Microwave Radiometer (MWR) observations at 0.6-2.2 GHz. These regions exhibit brightness temperatures colder than atmospheric thermal emissions. Juno provides in-situ measurements of electrons and protons in the Jovian magnetosphere at energies up to 10 MeV. High energy electrons can contribute to excessive heating of the lower stratosphere, previously not taken into account. We investigate the electron impact processes driving chemical reactions, and energy deposition in the ionosphere using a one dimensional atmospheric photochemistry package. The modeling efforts will provide important insights into the underlying physical mechanisms required for interpretation of the Juno MWR observations. This exercise will provide new insights into the aeronomy and energy budget of Jupiter's upper atmosphere, and provide predictions for upcoming radio occultation experiments of the Jovian aurora.

ASSESSING WATER CHEMISTRY DYNAMICS AND ENVIRONMENTAL SUITABILITY FOR MNOMEN REINTRODUCTION

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Mnomen, or wild rice (genus Zizania), is an aquatic grain endemic to the Great Lakes region that was driven to near extinction by industrialization and habitat destruction following 19th century western settler colonialism. It once served a significant ecological role, acting as a food source and habitat for numerous species in regional wetlands. Importantly, Mnomen remains a culturally and spiritually valuable food source for the Anishinaabe people. Researchers at the University of Michigan have recognized a need to move toward transformative changes to the relationship between the University and the Anishinaabe Great Lakes region. A previous study on University of Michigan properties identified Willow Pond at Matthaei Botanical Gardens in Ann Arbor, Michigan as a promising candidate for the reintroduction of wild rice. Willow Pond is a man-made pond draining into Fleming Creek via Parker Brook. The pond is shallow, slow-moving, has a thick, mucky sediment layer, and is inhabited by a wide variety of native and nonnative wetland plant species. However, limited data is available on the water chemistry of Willow Pond. This project investigated conditions at Willow Pond to assess the suitability of the site for the reintroduction of wild rice. Preferential growth conditions for wild rice are compared to data gathered from sondes installed upstream, downstream, and within Willow Pond. The sondes continuously monitored various water quality parameters including nitrate, dissolved oxygen, water temperature, specific conductivity, and pH through the Summer and Fall of 2023 that can be compared to local climatological data, particularly major meteorological events, to identify any environmental constraints, anthropogenic or otherwise, on the water chemistry of Willow Pond, as well as spatial and temporal trends in the water chemistry of Willow Pond. Large weather events, such as the storm which took place on Aug. 24th, 2023, increase both point and non-point source runoff, indicated by parameters such as nitrate concentration and specific conductivity. The impact of such weather events may have implications for the success of wild rice at Willow Pond, as the plant is sensitive to pollutants. Stability of the pond may be inferred by the variability of dissolved oxygen, pH, and the relationship between ambient temperature and surface water temperature. These analyses will establish baseline measurements prior to the reintroduction of wild rice in Willow Pond and will help to guide monitoring efforts of water chemistry aspects important to wild rice growth.

Temperature reconstruction of the Western Interior Seaway using carbonate clumped paleothermometry

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The Western Interior Seaway (WIS) was a vast, epeiric sea spanning a corridor of North America during the greenhouse climate of the Albian to Maastrichtian stages of the Cretaceous. The WIS has been the subject of study for decades, with well-established regional stratigraphy and fauna. However, many fundamental oceanographic questions remain unresolved, including the temperature of the seawater and circulation patterns. In this study, 61 well-preserved oyster samples from the seaway were analyzed using carbonate clumped isotope paleothermometry (Δ_{47}) to obtain latitudinal seawater temperature gradients for five different time intervals of the Cretaceous. Our Δ_{47} analyses yielded seawater temperatures warmer than modern, despite being at similar latitudes. We interpret this as the effect of dominant warm southern source waters and elevated carbon dioxide levels in the atmosphere. As seawater temperature is a fundamental driver of abiotic and biotic processes, it is extremely valuable to reconstruct WIS paleotemperature variation spatially and temporally. Broadly, our results provide insight into the Earth's response to a varying greenhouse climate, an important parameter to understand both in the Cretaceous and today.

EFFECTS OF MICROBIAL IRON REDUCTION ON ARCHEAN BANDED IRON FORMATIONS

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Early Earth oceans had a very different geochemical composition from modern ones prior to the Great Oxidation Event (2.4 Ga), with negligible free oxygen and abundant iron in their water columns and sediments. The first life on Earth is thought to have evolved under these anoxic conditions as far back as 3.5 Ga. During this time, mainly in the Archean eon (2.5-4 Ga), deposition of marine sediments led to the generation of banded iron formations (BIFs). While direct preservation of Archean microbes in these rocks is unlikely after 2.5 billion years of chemical and physical alteration, BIFs may still contain a biogeochemical record of their metabolisms. Archean BIFs as they exist now are comprised of iron-rich oxides, carbonates, and silicates, but these are thought to be secondary minerals altered from their original form by abiotic processes and possibly also by biotic processes as well during early diagenesis. A proposed primary phase of BIFs is an unstable Fe(II,III) salt called green rust; iron-respiring microbes living in Archean ocean sediments could have reduced the Fe(III) component of green rust, transforming it into secondary Fe(II)-rich minerals common in BIFs. In this project, we compared biotic and abiotic green rust transformation via the presence and absence of the model iron-reducing microbe *Shewanella putrefaciens* in Archean seawater conditions. We also explored the effects of silica on this system, since silica is thought to have been abundant in Archean oceans and is a key component of BIF secondary minerals but is also known to stabilize the otherwise volatile green rust, hindering its transformation into new mineral phases. Experimental green rust replicates were incubated first at room temperature, then hydrothermally aged to simulate diagenesis and accelerate mineral crystallization. Solution chemistry was monitored by measuring pH, iron, and silica levels. Mineral phases were analyzed using scanning electron microscopy, Raman microscopy, and X-ray diffraction. We found that green rust transforms into first siderite and subsequently magnetite, both common secondary minerals in BIFs, in both the presence and absence of *S. putrefaciens*. These results support the hypothesis of green rust being a primary BIF phase but suggest that siderite mineralogy is not a suitable indicator of microbial influence since it forms readily from green rust in both biotic and abiotic conditions. This transformation only occurred in the absence of silica, supporting existing evidence that silica impedes green rust transformation, and may constrain the paleoenvironmental conditions where BIF siderite formed. More research is needed to determine whether secondary BIF minerals other than siderite and magnetite could serve as indicators of early life on Earth, and to further explore the role of silica in BIF genesis and diagenesis. These insights would improve our understanding of early life on Earth and could help us identify signs of past or present life elsewhere in the solar system and beyond.

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Correlating the South American Low Level Jet and Precipitation Totals in Central Argentina

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[Not included in DOI at presenting author's request]

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Coral-based reconstruction of climate variability in the Western Indian Ocean

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[Not included in DOI at presenting author's request]

USING AIS DATA TO DETERMINE THE LOCATION OF OCEAN BOTTOM FIBER OPTIC CABLES

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Undersea fiber-optic cables form the backbone of global telecommunication networks, facilitating rapid data transmission across continents. However, the correct location of telecom subsea cables is generally inaccurate, if not completely unknown, or even sometimes undisclosed for safety reasons, as fiber optic cables represent a crucial geopolitical asset. Unlike on land, where tap tests with precise GPS data can be performed, subsea cables are not easily and inexpensively accessible. This limits their potential for proper seismic and environmental monitoring of near-coastal regions using Distributed Acoustic Sensing (DAS).

This study presents an approach to enhance the geolocation of undersea fiber-optic cables using Automatic Identification System (AIS) data from ships and large vessels transiting above subsea cables. We use a 4-month dataset from a cable located offshore Florence, OR. The first 50 km of the cable were probed with a Febus A1R interrogator unit using a 20 m channel spacing, a 100 Hz sampling rate, and a 40 m gauge length. During this experiment, we identified 32 vessels of different types and sizes, many crossing the cable multiple times. We precisely determine the location of some channels using the noise generated by ships and correlate it with AIS data. This study allows us to provide additional constraints on the location of fiber-optic cables and DAS channels.

Coupled Fluid-Kinetic Simulations of Dipolarization Fronts in Mercury's Nightside Magnetosphere

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As the only terrestrial planets with global dipole magnetic fields, the magnetospheres of Earth and Mercury are directly comparable. However, the lack of an ionosphere and weaker magnetic field at Mercury, combined with a different solar wind environment, results in several significant differences. Magnetic substorms are a common occurrence at both planets, but the smaller scale size of Mercury's magnetosphere and a relatively higher rate of magnetic reconnection means that different mechanisms govern the overall dynamics. This is particularly true at Mercury's nightside, where reconnection occurring in the magnetic tail of Mercury accelerates magnetic flux tubes containing heated plasma back towards the planet. These transient structures, known as dipolarization fronts, are slowed and diverted as they approach the planet, resulting in localized enhancements in the magnetic field in the near-Mercury environment. Compared to Earth, the small system size and short characteristic time scales at Mercury would imply that dipolarization front dynamics are inherently time-varying. The MESSENGER spacecraft, which orbited Mercury from 2011-2015, directly observed dipolarization fronts, but open questions about their evolution, dynamics, and role in broader magnetospheric processes persist. To contextualize these observations, we are conducting coupled fluid-kinetic simulations of Mercury's magnetosphere using the Space Weather Modelling Framework, which allows for the physics of these structures to be accurately captured. The time-dependent, high-resolution output of these simulations allows for a detailed study of individual dipolarization fronts, to quantify their contribution to the accumulation of magnetic flux in the planet's nightside environment. By repeating our simulations for different solar wind conditions that Mercury encounters along its eccentric orbit, we will establish a quantitative connection between upstream conditions and dipolarization front occurrence. We will also investigate how the depth of penetration of dipolarization fronts depends on their physical properties, such as the specific entropy. This analysis aims to help to interpret MESSENGER observations and constrain the distribution of plasma which ultimately impacts the surface to generate Mercury's tenuous exosphere.

OXYGENATED ORGANIC VOLATILE COMPOUND MEASUREMENTS IN AN ARCTIC OILFIELD

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The Arctic is currently warming faster than any other place on Earth, and our understanding of radiative forcing and chemistry in this region are poorly constrained due to the complexities of primary emission and secondary production of aerosol precursors. Volatile organic compounds (VOCs) are emitted from anthropogenic sources such as oil extraction in addition to natural sources such as the snowpack. These emissions then react with atmospheric oxidants to form oxygenated VOCs (OVOCs). However, Arctic atmospheric chemistry commonly involves abundant halogen radicals (Cl and Br atoms) relative to other regions, contributing to more highly oxygenated products and secondary organic aerosols. Despite its importance, this halogen chemistry and the resulting products are understudied, limiting our current understanding of the Arctic climate.

Utilizing state-of-the-art instrumentation, this study aims to develop a better understanding of the relationships between halogen chemistry, VOCs, and OVOCs in the Arctic. Between February and March 2020, a Vocus NO^+ chemical ionization time-of-flight mass spectrometer coupled to a gas chromatograph was deployed at Oliktok Point located in the North Slope of Alaskan oil fields at a Department of Energy Atmospheric Radiation Measurement(ARM) mobile facility. Using these speciated VOC measurements, we identified specific precursor and product VOCs, including OVOCs.

Here we present an analysis of OVOC temporal trends as they correlate between other VOCs and additional trace gasses such as ozone. Through these observations we assess changes in both primary emissions and their associated secondary reaction products. These results better inform our understanding of halogen chemistry and consequences for the Arctic atmosphere, as well as other impacted regions including coastal areas. As the Arctic continues to warm, expanding resource extraction and shipping lanes will continue to increase primary anthropogenic emissions in the area. As emissions increase, understanding

this chemistry will become increasingly important towards constraining potential future conditions.

Helmholtz-Magnetometer Ensemble Calibration for Space Environments

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Magnetospheric constellation missions, consisting of multiple spacecraft working in tandem, need many accurate magnetometers to simultaneously observe the magnetosphere globally to understand its response to solar wind inputs. As future missions call for increasing number of spacecraft, the ability to build and test large numbers of research quality magnetometers is essential. Most commercially available magnetometers are not precise or accurate and employ different techniques to calibrate sensor bias and drift. Our solution, CHIME or Coiled Helmholtz and Inductive Magnetometer Ensemble, calibrates commercial PNI RM3100 magnetometers by surrounding them with ground calibrated, integrated coils that measure the drift of calibrated biases.

Helmholtz coils are common tools for pre and in-flight calibration of magnetometers because they allow for a known field to be placed on sensors to calibrate scale factor, orthogonality, and offset. CHIME coils apply a known magnetic field onto the RM3100 magnetometer to correct for measurement gain, orthogonality, and off-set drift. The difference in magnitude of the known and measured magnetic fields is defined as the scale factor and orthogonality bias, while the bias from zero field is the offset. This calibration procedure can be applied both on the ground and in-flight.

For ground calibration, the offset and scale factor biases are quantified as a function of both applied magnetic field and temperature to simulate dynamic space-like environments. The instrument error from an RM3100 is measured from extensive characterization of the magnetometer, using in-lab magnetic mu-metal shield cans and thermal testing chambers at the University of Michigan Magnetic test facilities. The in-flight calibration procedure is simulated and compared to other calibration techniques to identify the best techniques. CHIME works in parallel with standard two-step calibration algorithms to accurately determine the drift of bias in the RM3100. The calibration procedure is validated through adding random scale factor and offset to ESA's Swarm high resolution data, then using the in-flight CHIME and two-step algorithm calibration procedure to solve and correct the added bias. This procedure can be automated to run during quiet geomagnetic periods or slowly varying active intervals to create a self-calibrating magneto-inductive sensor without the need to compare with a priori geomagnetic field models.

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Detroit Watershed and Coastal Georgia Precipitation and Streamflow Spatial Analysis in Correlation to Flooding Events and Property Damages

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The effects of flooding within low coastal areas are expected to increase with sea level rise predictions. Current methods of flood prediction do not take into account nonstationarity of flood inducing factors; the fact that sea level rise or precipitation among other atmospheric events are not expected to sustain past trends according to climate forecasts. They also do not take into account smaller events and focus on larger, extreme occurrences. This research alternatively focuses on the creation of maps to perform spatial analysis at a county level.

Preliminary spatial analysis of precipitation events within Michigan and Georgia has been completed. Mapped factors of max daily, hourly, and average annual precipitation for each available recording station within a determined year range. Their correlation to data on stream discharge (aka stream flow or volume of water flow per unit of time) has also been progressing. Recently, research was scoped to coastal Georgia and the Detroit watershed in order to make potential results usable for a Great Lakes Integrated Sciences and Assessment (GLISA) and University of Georgia (UGA) project. Different probability and statistical approaches have been made to link the past discharge and precipitation data to building flood damages. Mapped values of individual building worth and property damage from FEMA data has enhanced analysis by emphasizing flooding economic impacts.

Through this GLISA/UGA partnership further linkages between precipitation events, stream discharge, and flooding will be made in selected locales. Especially to help predict frequencies of severe or minimal nuisance flooding, to make economic forecasts and assist policy decisions, or to generally better understand multi-factor influences on flooding.

Carbonate clumped isotope (Δ_{47}) temperature reconstructions from the Plio-Pleistocene Florida Platform: Assessment of a regional extinction event

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In southern Florida, a sequence of densely fossiliferous shell beds illustrates a regional extinction event over the course of the Late Pliocene through the Middle Pleistocene. Although cooling water temperatures have long been invoked as a potential driver of this extinction event, the marine temperature history of the Plio-Pleistocene Florida Platform remains poorly quantified. In particular, prior paleotemperature and seasonality estimates based on $\delta^{18}O_{carb}$-thermometry yield ambiguous results due to poor constraints on $\delta^{18}O_{water}$ values in this unique platform environment. In this project, we apply high-resolution Δ_{47}-sclerochronology to numerous fossil bivalves to produce the first quantitative estimates of (i) mean water temperatures, (ii) seasonal extreme temperatures, and (iii) mean $\delta^{18}O_{water}$ values in each of the major Plio-Pleistocene formational units of southern Florida. Here, we present Δ_{47}-derived temperature and $\delta^{18}O_{water}$ reconstructions from the Pinecrest Beds of the Tamiami Fm. (Late Pliocene), the Caloosahatchee Fm. (Early Pleistocene), the Bermont Fm. (Middle Pleistocene), and the Fort Thompson Fm. (Late Pleistocene), documenting changes in temperature seasonality across the extinction interval. Our formation-level temperature and seasonality estimates are used to evaluate hypotheses of marine climate change as an extinction driver. Reconstructed $\delta^{18}O_{water}$ profiles indicate subannual-scale and formation-to-formation variability in past $\delta^{18}O_{water}$ compositions, demonstrating the utility of Δ_{47}-thermometry in this unique geologic setting to unambiguously constrain past water temperatures.

Thermal State and Solidification Regime of the Sulfur-Rich Martian Core: Insights from the Melting Behavior of FeNi-S at High Pressures

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Recent observations from the InSight Mission suggest that the core of Mars contains 18 to 26 wt.% sulfur, considerably more than the previous estimates of up to 12 wt.% (Stahler et al. 2021). While there is a comprehensive understanding of the melting behavior of the iron-rich compositions, that of the sulfur-rich compositions is completely unconstrained. Here we conduct high pressure experiments using a multi-anvil press in order to determine the liquidus curves of the sulfur-rich side of the FeNi-S system at 20 to 25 GPa, the pressure applicable to the martian core. We will quantify how much the presence of nickel lowers the melting temperature of FeS., and the effect of nickel on the liquidus curve of FeNiS. The expected results will further our understanding of the thermal state and solidification regime of the martian core. The study will hold compelling implications, providing an insight into the possible future restart of a magnetic field within the core of Mars, as well as its surface habitability.

Stähler, S.C. et al. Seismic detection of the martian core, Science 373, 443–448 (2021).

Timing of monazite formation in the Colombian emerald deposits

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The Colombian emerald deposits are distinctive for their association with non-magmatic hydrothermal fluids within sedimentary host rocks. Emeralds occur in veins and breccias rich in calcite, dolomite, albite, and pyrite, occasionally rare earth element (REE) minerals such as parisite-(Ce), monazite, and xenotime. Among these, monazite is of notable interest for being a reliable geochronometer, despite the elusive nature of its occurrence. Discriminating between detrital, authigenic (formed during sediment diagenesis), and hydrothermal origins for monazite is crucial for understanding its formation. This study employs a combination of high-resolution imaging, chemical mapping, and in situ geochronology to elucidate the various origins of monazite within emerald mineralization. Results indicate that monazite is predominantly situated within the host rocks, whereas xenotime is primarily associated with hydrothermal veins adjacent to albite, F-apatite, and occasionally emeralds. Parisite-(Ce) occurs alongside carbonates and emeralds within hydrothermal veins, as well as within the host rocks. Nonetheless, some monazite and xenotime grains are found in their non-primary locations. Monazite displays spatial association with minerals like framboidal pyrite, albite, and rutile, forming triple junctions, and containing abundant organic-rich inclusions. While these features indicate an authigenic origin, Ce, La, and Th zoning across grains coupled with U-Th-Pb ages reveal a more complex history. Several monazite crystals show cores with ages ranging from 140 to 70 Ma, and rims with younger ages (~70-35 Ma), implying a multi-stage crystallization process. In contrast, the lack of significant zoning in vein-associated xenotime and parisite-(Ce) suggests a single-stage crystallization consistent with their ages (< 75 Ma). Notably, a subset of monazite grains exhibits even more intricate zoning patterns comprising at least three distinct domains. I believe this reflects: i) detrital origin for the innermost cores, ii) overgrown during diagenesis for the middle rims, iii) fluid-mediated overgrown of the outermost rims during hydrothermal activity coinciding with emerald crystallization. The latter is supported by the euhedral character of the crystals (sharp edges), lack of inclusions, and coarser size (average > 500 microns in diameter). These findings suggest that the host rocks were the primary REE source, with hydrothermal activity promoting leaching and reprecipitation, rather than introducing external metal sources. In summary, this research offers new insights into the complex mineralization processes of emeralds and REE minerals in Colombia, highlighting the multi-faceted origins of monazite and its companions in this unique geological setting.

Investigating and Correcting Singular Behavior in Physics-Based Auoral Models

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Space weather poses a global threat to power grids in the form of geomagnetically induced currents (GICs). Charged particles precipitating (e.g., entering the atmosphere from space) from the magnetosphere - auroral precipitation - create regions of the atmosphere that allow strong currents - conductance channels - and are a key driver of GICs. Contemporary models lack an ability to accurately forecast their effects. The Space Weather Modeling Framework (SWMF) has new capabilities for calculating auroral precipitation using a semi-physical model, the Magnetosphere Ionosphere Thermosphere (MAGNIT) Auroral Precipitation Model, driven by physical magnetohydrodynamic (MHD) parameters in the magnetosphere from the Block Adaptive Tree Solar-wind Roe Upwind Scheme (BATS-R-US). These capabilities open up new possibilities, but have not been fully tested. During idealized simulations, MAGNIT shows behavior that is not realistic in the form of a high intensity, large scale, and stable duskside glow. In this poster we investigate the cause of this feature and address potential solutions. In order to determine the cause, we analyzed the physical features from BATS-R-US that drive the precipitation calculations in MAGNIT. To analyze the relationship between these features, we developed new visualization tools to compare MHD values to their mapped ionospheric counterparts, and to determine the size and shape of the Northern Hemisphere polar cap. These tools were employed to explore the relations between the physics, BATS-R-US model, and MAGNIT. Through this process, we found two strong relationships, one between pressure in the magnetosphere and the average energy of precipitating particles in the ionosphere, and one between vorticity in the magnetosphere and energy flux in the ionosphere. Current results show that an asymmetrical standing signature in the magnetotail is the main driver of the duskside glow. Potential solutions to this issue are currently being developed, with an expectation that the main issue is an oversaturation of values in MAGNIT from a large influx of high energy particles.

Assessing the Degree of Lake Sedimentary Organic Matter Degradation Under Different Water Column Oxygenation Levels

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Lakes are an important resource because they provide drinking water, host biodiversity, and play an essential role in economic growth. Therefore, it is essential to study how lake nutrient dynamics will change under shifting climatic conditions. Rising surface water temperatures caused by climate change are expected to intensify lake stratification and increase periods of water column anoxia. Subsequent low levels of oxygen in lakes are expected to impact major elemental cycles including nitrogen which influences aquatic primary productivity. We analyzed four sediment cores (n = 19 total samples) and a microbial mat sample (n = 1) from Middle Island Sinkhole (MIS), a 23m deep anoxic site within Lake Huron, Michigan, to understand organic matter degradation under low oxygen water column conditions. MIS is fed by brackish, anoxic groundwater leading to microbial and biochemical features distinct from overlapping Lake Huron waters. We compared the degree of organic matter degradation in MIS to one Lake Huron core (n = 6 total samples) which contains a well-oxygenated water column. The Total Hydrolysable Amino Acid (THAA) degradation Index (DI) was used to assess the degree of organic matter degradation for sediments of the two study sites; this proxy is based on changes to the mole fraction of certain amino acids upon degradation. A lower DI value signifies a greater degree of degradation in amino acid organic matter. As expected the percent nitrogen and individual amino acid concentrations track each other with sediment depth for both MIS and Lake Huron samples due to THAAs as a primary source of nitrogen. A common trend observed across all of the cores is that the amino acids with the highest percent mole contribution are consistently the same (Gly, Asp, Ala, Glu, and Ser). Likewise, the amino acids with the lowest percent mole contribution are consistent across all cores (His, Met, Tyr, and Cys). However, we find that oxic Lake Huron sediments exhibit slightly lower DI values on average (DI = -1.17×10^{-10}) compared to the anoxic MIS sediments (DI = 1.97×10^{-11}) indicating that organic matter within the oxygenated water column may undergo more pronounced degradation. Our initial findings suggest that anoxic aquatic environments may better preserve organic matter influencing nutrient cycling.

EFFECT OF CARBONATE MELTS ON THE DEEP CARBON CYCLE

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Archean terrestrialization of the biosphere and impacts on marine ecosystems

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Common perceptions of early life include deep-sea hydrothermal vents and marine microbial communities, with terrestrial ecosystems and influences considered marginal or negligible. As a window into these Archean ecosystems, researchers use an array of evidence, including macro-and mesoscopic microbialites, microfossils, and geochemical traces such as organic carbon and isotopes. To interrogate this perception of non-terrestrial early life, we compiled evidence of Archean microbialites and their depositional environments, gathering 74 instances of microbialites (divided by depositional environment). We also collected 35 entries of evidence for terrestrial life during the Archean. Both marine and terrestrial evidence spanned from 3.48 Ga to the end of the Archean at 2.5 Ga, with diverse depositional environments throughout. Notably, we found evidence for life in fluvial ecosystems that was temporally but not geographically extensive; while Archean fluvial deposits are fairly widespread, most have not yet been studied with a focus on evidence for life. Additionally, our compilation found that hydrothermal and tidal influences were blurring the distinction between terrestrial and marine, countering the perception of minimal terrestrial influence on the marine biosphere. Hydrothermal systems were a common feature for many Archean microbialite units; we found several described as having evidence of subaerial exposure that were nonetheless identified as marine. Further, studies have found evidence of terrestrial hot springs as a depositional environment for some of the earliest preserved evidence of life. Tidal influences further confound the divide between terrestrial and marine systems: we found that 45% of "marine" microbialites formed in tidal zones, and for some others, the literature was unclear whether they were marine or tidal. While modern coastal and tidal regions already have high terrestrial inputs and unique conditions, Archean tidal zones would likely have had even more extensive and dramatic changes, as tidal magnitude and strength would have been greater. Large expanses would be frequently subject to subaerial exposure and high flow velocities, with the potential for extensive transport of terrestrial materials and nutrients that could fuel the marine biosphere. Overall, we found the evidence for a marine ecosystem disconnected from terrestrial influence to be lacking, suggesting that a broader conception of early life is necessary — one which accounts for the emergence of early land, and the ubiquity of life across ecosystems.

Isolating *Microcystis aeruginosa* from Western Lake Erie

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Microcystis aeruginosa is the most common cyanobacterial strain found in Lake Erie harmful algae blooms (HABs). The presence of *Microcystis* is concerning as it is capable of producing a cyanotoxin called microcystin that poses serious health threats to humans and aquatic life, as well as causing harm to local economies through a reduction in recreation. The Toledo drinking water crisis brought Lake Erie HABs to the national level in 2014, as five-hundred-thousand residents were without water for several days.

Due to the severity of harm that the presence of toxic cyanoHABs have, this project aims to better understand *Microcystis aeruginosa* as a whole. This includes mapping out the species diversity, toxicity, and how to better control factors that trigger the breakout of blooms. In order to derive data and run any sort of controlled experiment, months are spent growing colonies derived from Lake Erie field samples. After several rounds of culture isolation and microscopy, 16s rRNA gene sequencing is done to confirm *Microcystis aeruginosa* was grown.

Once confirmed, cultures are maintained and added to our Western Lake Erie culture collection and sent out for genome sequencing. By continually growing and isolating strains of *Microcystis* taken from recent collection cruises, a diverse library of genomes is created. Having a wide range of genomes is essential for critically evaluating the species as a whole, which is the first step to gaining control over outbreaks that threaten access to clean and safe water.

CONTROLS ON HYDROGEN PEROXIDE IN LAKE ERIE

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Hydrogen peroxide (H_2O_2) is present in all natural waters where it influences water quality. H_2O_2 is produced by light-dependent biotic and abiotic biogeochemical processes, while the main sink for H_2O_2 is light-independent decay by aquatic microorganisms. However, controls on the sources and sinks of H_2O_2 remain too poorly known to understand the impact of H_2O_2 on water quality. For example, the causes and consequences of relatively high concentrations of H_2O_2 in the western basin of Lake Erie, compared to other freshwaters, are not well known. One knowledge gap is the influence of biological processes in sediments on H_2O_2 concentrations in Lake Erie waters. Given current understanding of the influence of sunlight on the sources and sinks of H_2O_2, sources of H_2O_2 are expected to be higher in the sunlit surface waters compared to the relatively dim (or dark) sediments in Lake Erie, while sinks for H_2O_2 may not differ between surface and bottom water overlying the sediment. To test these ideas, laboratory incubations were conducted with sediments and bottom water collected in late May and June, 2023, in the western basin of Lake Erie. Sediments and bottom water were incubated in the dark and in the light, alongside no-sediment controls comprised only of Lake Erie bottom water. H_2O_2 concentrations were measured as a function of incubation time alongside supporting biological and chemical measurements of water quality. In addition, H_2O_2 concentrations were measured directly in bottom and surface waters in the western basin of Lake Erie in mid-July, 2023, over several days during the day and at night. In both the incubation and field results, there was no clear, significant effect of the light versus dark treatment or field conditions on H_2O_2 concentrations. During the incubations, H_2O_2 concentrations were significantly higher in the no-sediment control compared to the treatment with sediment, suggesting that sediments may be a sink of H_2O_2 from the water column. In the field, H_2O_2 concentrations were generally higher in the bottom water (near-sediment) compared to the surface waters, suggesting that sediments may be a source of H_2O_2 to the water column. An alternative explanation for the field results is that biological decay of H_2O_2 was higher in surface versus bottom waters in Lake Erie. Together, the results suggest potentially dynamic influences of sediments on H_2O_2 concentrations to lake water and challenge the current understanding of controls on H_2O_2 in Lake Erie and similar freshwaters.

Reconstructing Paleocene/Eocene atmospheric carbon isotopic composition with terrestrial organic matter from the Hoback Basin, Wyoming

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It is necessary to track the fluxes of carbon into the atmosphere when investigating ancient warming events as potential analogs for modern anthropogenic climate change. The stable carbon isotopic composition of the atmosphere ($\delta^{13}C_{atm}$) is useful for this purpose, as it reflects the contribution of isotopically distinct carbon sources and sinks. However, $\delta^{13}C_{atm}$ is poorly constrained throughout much of Earth's history. The terrestrial biosphere provides a promising archive for this information, as life on land interacts directly with the atmosphere and is present in the geologic record from the late Archaean. The carbon isotopic composition of terrestrial organic carbon ($\delta^{13}C_{org}$) is thus used as a proxy for $\delta^{13}C_{atm}$; yet $\delta^{13}C_{org}$ integrates additional information about the ecosystem and climate in which it formed. Here, we present new terrestrial $\delta^{13}C_{org}$ data from late Paleocene (Hoback Formation) and early Eocene (Pass Peak Formation) strata of the Hoback Basin, Wyoming. We use these data to reconstruct $\delta^{13}C_{atm}$ for comparison with established records derived from marine foraminifera. In doing so, we evaluate the efficacy of terrestrial organic carbon as an archive for atmospheric conditions and a tool for correlation with marine proxies. We find that average terrestrially-derived $\delta^{13}C_{atm}$ decreased from -3.78‰ to -5.67‰ between the Hoback and Pass Peak Formations, which aligns with the trend observed in foraminifera-based $\delta^{13}C_{atm}$ between the late Paleocene and the early Eocene. In both records, $\delta^{13}C_{atm}$ estimates from the late Paleocene are more positive than known atmospheric carbon sources, indicating unexplored vital effects and/or a shift in global carbon cycle dynamics at the time. However, high variability of both terrestrial and marine reconstructions of $\delta^{13}C_{atm}$ precludes high-resolution chemostratigraphic correlation and implies alteration of atmospheric signals by environmental and/or diagenetic processes. Furthermore, we find no significant differences in means or variability between $\delta^{13}C_{atm}$ reconstructed from fossil wood samples and from all other organic matter types, challenging previous assertions regarding the dependability of fossil wood for estimating original plant $\delta^{13}C$. These results highlight the need to determine appropriate procedures for disentangling the various influences on terrestrial $\delta^{13}C_{org}$ before it can be used as a reliable proxy for paleoatmospheric conditions.

MULTI-SCALE ASSESSMENT OF LAYERED ROCKS FOR ENHANCED ROCK STRENGTH ESTIMATION MODELS

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Earthquake-triggered landslides pose a significant hazard in many regions of California where large population centers are developed on geologically young and fragile rock masses near active fault systems. Conventional landslide susceptibility models utilize Mohr-Coulomb strength parameters to assess slope stability under earthquake-induced loading, but accurately assigning these properties across large areas is challenging, particularly in regions with significant lithologic and structural variability. In this study, we examine the Topatopa Mountains of southern California to characterize changes in rock properties both within and across mapped stratigraphic units, and the impact of these changes on regional rock mass strength. We combine thin section analysis, field-based rock strength measurements, shallow 2D geophysical surveys, and regional earthquake-triggered landslide back analysis, to characterize differences in material properties that influence rock mass strength across scales ranging from microns to kilometers. The Topatopa Mountains expose Cretaceous through Pleistocene age clastic strata of mainly sandstone and shale lithology where maximum burial depth correlates with rock age. We find that rock mass strength in sandstone becomes more uniform with age as weaker, clast-supported sandstones undergo progressive increases in compaction and cementation. Sandstones in mid-Miocene and younger stratigraphic units have highly variable field-based rock mass characteristics; some beds have comparable strength to Eocene age units, while others are mechanically like soil. Regional-scale strength values derived from back analysis of younger units are more uniform and favor the strongest endmembers. We posit that the most resistant beds control topographic form, which is defined by dip-parallel back-slopes to steep face-scarps. Earthquake-triggered landslides dominantly occurred as block failure on the over-steepened face-scarps, resulting in regional strength values reflecting the strongest sub-units. The lowest back-calculated strengths were observed in regions proximal to fold hinges, indicating that fracture density and local stress fields negatively influence regional rock strength. We consider the implications of these observations for the western Topatopas, for which there is no earthquake-triggered landslide inventory. We conclude that while older sandstones exposed in the western Topatopas have more uniformly high strengths, they are still interlayered with relatively weak shales and hold similar topographic form that is potentially unstable in the event of a high magnitude earthquake.

Collection and Characterization of Raman Spectra of Individual Arctic Sea Spray Aerosol Particles

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The temperature of Arctic air is increasing at a rate more than twice that of the global average. In the Arctic, sea spray aerosol (SSA) particles are generated at the ocean's surface via wind-driven and wave-breaking processes. SSA particles impact the Arctic climate by forming with clouds, as well as scattering and absorbing radiation. The organic makeup of SSA particles is affected by the local marine microbial community. Sea ice algae and bacteria emit organic substances which partition to the sea surface microlayer, coating SSA particles as they are ejected from the ocean surface. The organic compounds in SSA often form a coating around inorganic salts, which decreases the hygroscopicity of SSA and hinders a particle's ability to activate as a cloud droplet. Therefore, the composition of organics produced by the marine microbial community impacts the interaction between SSA and clouds. In order to characterize the molecular composition of organics within individual Arctic atmospheric particles, Raman microspectroscopy was carried out on particles collected during the Multidisciplinary Drifting Observatory for the Study of Arctic Climate (MOSAiC) expedition which took place from September 2019 to October 2020 aboard the German Icebreaker Polarstern in the central Arctic.

Assessing substrate vs. light limitation of photochemical production of H_2O_2 in arctic surface waters.

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Hydrogen peroxide (H_2O_2) is ubiquitous in fresh and marine waters where it is an oxidative stressor to microbes and influences the redox cycling of trace metals and carbon. H_2O_2 is produced in natural waters predominately by a photochemical reaction of (chromophoric) dissolved organic matter (CDOM). In a rapidly warming Arctic, thawing permafrost soils are expected to export more reactive CDOM to sunlit surface waters, which are expected to be increasingly ice-free and exposed to sunlight for greater portions of the summer season. Thus, H_2O_2 concentrations may increase in proportion to increasing concentrations of CDOM and increasing sunlight availability in the arctic freshwaters. However, H_2O_2 production depends on concentrations of CDOM only in waters low in concentrations of photochemically reactive CDOM (i.e., substrate-limited waters). In waters with high concentrations of photochemically reactive CDOM, H_2O_2 production is limited by the sunlight reaching the water (i.e., light-limited waters). In this study we quantified the substrate and light limitation of H_2O_2 production in streams, rivers and lakes of the Alaskan Arctic in summer 2022 and 2023. In each water, concentrations of CDOM were measured along with the apparent quantum yield of H_2O_2 ($\boldsymbol{\phi}H_2O_{2\lambda}$) produced from CDOM, a measure of the reactivity of CDOM to produce H_2O_2 per mol photon absorbed as a function of wavelength. The $\boldsymbol{\phi}H_2O_{2\lambda}$ increased with increasing aromatic content of the CDOM. Photochemical production rates were found to depend strongly on the $\boldsymbol{\phi}H_2O_{2\lambda}$ and thus H_2O_2 production in arctic freshwaters is limited by the reactivity of CDOM to produce H_2O_2 (i.e., substrate limitation by composition). Photochemical production rates for most waters in this study were also limited by CDOM concentration and sunlight. Thus, in arctic freshwaters, both a rise in CDOM concentrations and changes in sunlight availability will increase photochemical production of H_2O_2. For example, results from this study predict that thawing permafrost soils and the associated export of reactive CDOM to surface waters along with less ice cover on arctic lakes will have a large impact on photochemical production of H_2O_2. The approach to quantify substrate and light limitation in the photochemical production of H_2O_2 in arctic freshwaters in this study is urgently needed at lower latitude waters receiving more sunlight than in the Arctic, particularly in temperate and boreal waters where CDOM concentrations have increased over the past 30 years.

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Resolving Lake Erie's Evaporation Estimates Using Stable Isotopes

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Investigating Hydroclimate Changes in Eastern Africa: A Focus on the Miocene

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Investigation of Seismic Velocity Changes in Mexico City with Seismic Interferometry and Distributed Acoustic Sensing

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Mexico City, the most densely populated city in the Americas, faces considerable seismic hazards. Traditional seismometers often grapple with limited spatial coverage, impeding detailed observations in urban settings. In contrast, Distributed Acoustic Sensing (DAS) has the capability to transform standard telecommunication fiber-optic cables into dense seismic arrays, presenting significant potential for high-resolution spatiotemporal monitoring. Consequently, in May 2022, we implemented a DAS interrogator in Mexico City on a long-term basis to collect data for observational studies in the region. The fiber traverses the city from south to north along a 29-kilometer path. The dataset consists of 2266 channels with a spacing of 12.8 meters and a sampling rate of 200 Hz.

On September 19, 2022, a Mw7.6 earthquake occurred in Michoacán, approximately 450 kilometers away from the city. The DAS system yielded high-quality, ultra-dense, and unique data for this specific earthquake. One of the objectives of this study is to evaluate the earthquake-induced changes in the sedimentary basin material properties. To achieve this goal, we utilize seismic interferometry on the ambient noise field of DAS data and the stretching method to monitor seismic velocity variations in Mexico City. Our analysis reveals a decrease in velocity in certain areas of the city following the 2022 Mw7.6 earthquake. The findings suggest that DAS can effectively monitor velocity variations in urban environments, providing valuable insights for urban hazard assessment.

Investigating Connections Between Tectonics, Hydroclimate, and Fauna in Early-Cenozoic Northern Basin and Range via Stable Isotopes

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Ambiguity persists regarding the relative importance of two proposed primary drivers of Basin and Range extension in the western USA: 1) platewide change in relative motion of the Farallon slab beginning ~45-40 Ma; 2) folding of the Farallon slab beginning in north-south extremes at ~60Ma, and sweeping inward to the latitude of southern NV at ~15 Ma.To resolve this question, we consider the rates and magnitudes of extension of a semi-continuous basin in the Northern Basin and Range: Sage Creek Basin (SCB), in southwest MT, where folding of the slab distinctly precedes the velocity change – and therefore offers a distinct window of time to assess the relative impact of each on rates and magnitude of Basin and Range extension.

Extension in SCB initiated along the Red Rock Fault (RRF) during the Cretaceous/Paleocene and is recorded by Eocene-Pliocene vertebrate- and paleosol-rich fluvial and volcaniclastic deposits. To constrain the timing of the *initiation* of extension, we will analyze (U-Th)/He thermochronology of Cretaceous clastic RRF footwall rocks. We then seek to constrain the timing of the *greatest magnitude* of extension using oxygen stable isotopes paleoaltimetry on Eocene-Miocene vertebrate tooth enamel and authigenic Paleocene limestone from the RRF footwall. Our estimates of elevation will serve as a proxy for the magnitude of crustal thinning. Considering that folding of the Farallon slab occurred earlier than rollback in the Northern Basin and Range, we propose that if *rollback of the Farallon slab* caused the extension of the Basin and Range, we expect estimate the largest magnitude of elevation change following ~60 Ma; meanwhile, if *folding of the Farallon slab* caused extension of Basin and Range, we expect see the largest magnitude of elevation change following ~45-40 Ma. From our isotope analyses, we may also elucidate large-scale shifts in regional hydroclimate and faunal turnover in the intermontane western USA, including across the PETM and Eocene-Oligocene Transition.

Differences in the mineralogy and morphology of Eocene Green River Basin stromatolites across paleolake stages

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Stromatolites from the Green River Basin of Wyoming mark deposition during various stages of a paleolake in the Early Eocene Climatic Optimum, a period of high pCO_2 and temperature. These samples, ranging in age from 51.6 Ma to 49.6 Ma and size from millimeter to decimeter scale, recorded a wide variety of morphology and mineralogy possibly driven by variations in regional lake conditions. Analysis was conducted through physical sample categorization, the creation of 3D images using X-ray computed microtomography (µCT scanning), and preliminary bulk mineralogical analysis using X-ray diffraction to inform future elemental mapping of sample faces. 27 µCT scans were conducted with segmentation of key features on 21 samples, and 4 samples representative of stromatolite morphological diversity were analyzed using XRD. The three sites exhibited primarily dome and digitate macroscale structures and fine laminations on the mesoscale, with internal changes in color and structure. Multiple branching styles were observed between the sites, revealing distinct morphologies. Our morphological analysis must factor in the presence of diagenetic alterations, which can impact preservation. Sample mineralogy included primary carbonates as well as likely diagenetic chert and dolomite. We illustrate the diversity of stromatolite preservation present in one paleolake system by presenting elemental analysis in tandem with µCT scans. This diversity matches changes the lake transitions between saline lacustrine and mudflat playa systems. Future geochemical work will use elemental mapping with scanning electron microscopy and electron microprobe to investigate the relationships between the biological growth of the microbial mats preserved in stromatolites and the lake chemistry they record.

High-Pressure Melting Behavior of Potassium Carbonate (K_2CO_3) in Subducted Slabs: Implication for Deep Carbon Cycle

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As potential carriers of carbon back to deep Earth through subducted slabs, carbonates are highlighted due to their significance for the deep carbon cycle. Previous studies have yielded inconsistent results, with large discrepancies exceeding 180 ℃ in the melting temperatures of K_2CO_3 at pressures above 3 GPa. Here we provide tighter experimental constraints on the melting point of K_2CO_3 near 3 GPa through validation of melting detection criterion at 1 bar using a high-temperature furnace, precise pressure calibration based on the established melting curve of sodium chlorite (NaCl), duplicate high-pressure melting experiments using improved in situ ionic conduction method with a multi-anvil press, and cross-checking the results using the conventional Pt-sphere-marker experiments and the state-of-the-art radiography technique. We determined that K_2CO_3 melts at 1380±5 ℃ at 3 GPa, confirming previous results from double-sided ionic conduction method but are higher than the results from Pt-sphere-marker experiments using sealed Pt containers and a piston-cylinder apparatus. We hypothesize that the discrepancy is caused by trapped water in sealed Pt containers and are conducting experiments to test this hypothesis. By comparing the melting behavior of K_2CO_3 and other common carbonates in the deep mantle conditions, our study will shed light on the transportation and storage of deep carbon. Applying the knowledge of melting behavior and physical properties of carbonates, we will explore the implications for the origin of the geophysical anomalies in low-velocity zones at the lithosphere-asthenosphere boundary.

Decadal Variability of Tropical North Atlantic Sea Surface Temperatures based on Venezuela Coral Geochemistry (1869-1994)

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The tropical North Atlantic (TNA) Ocean significantly influences local and regional climate, such as hurricane formation in the main development region and precipitation patterns in the southern United States, northeast Brazil, and the African Sahel region. The Atlantic Multidecadal Oscillation (AMO) drives sea surface temperature (SST) variability in the TNA and is characterized by alternating periods of warming and cooling over decades. Limited observational data hinders our understanding of pre-1950s SST variability and the extent to which current changes in TNA SST can be attributed to external forcing. This study's coral proxy record addresses these gaps by extending the SST record to 1869, providing the longest temperature reconstruction in the region. The elemental (Sr/Ca) and isotope ($\delta^{18}O$) data of a *Siderastrea siderea* coral from Venezuela were analyzed in order to reconstruct TNA SST. The coral geochemistry data were validated against instrumental SST and anomaly data (1950-1994), and a weighted least squares regression calibrated the equation to convert the Sr/Ca and $\delta^{18}O$ values to SST. The coral record accurately reflects the site's SST, and its variability is consistent with the TNA and AMO indices. Decadal SST variability is present, with cooling periods from 1869 to 1920, followed by warming from 1920 to 1974, and subsequent cooling from 1974 to 1990. This record provides an index of larger-scale variability in the Atlantic Ocean dating back to 1869. The duration of warm and cool periods appears to be increasing, resulting in longer anomalous periods that may adversely impact humans. By extending limited instrumental data, this coral record offers valuable insights into natural TNA variability before anthropogenic warming and its response to atmospheric greenhouse gas concentrations. Additionally, the data can evaluate climate models' accuracy in reproducing these findings. The coral record presented here is the first step in expanding our understanding of climate variability in this region prior to the 1950s, but further research is needed to understand the mechanisms behind TNA's decadal variability and the impact of human activities on climate.

The Effects of CO2, Temperature and Nutrients on Microcystis Growth and Toxin Production

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The harmful bloom-forming cyanobacteria species, *Microcystis,* is expected to become more globally abundant in the future due to climate changes. Such change includes: increased runoff of nutrients, water stratification of lakes, warming waters and acidification from increased atmospheric CO_2 levels. *Microcystis* prefer warmer environments, can produce different strains quickly and can control their buoyancy to reach deeper in the water column. These adaptations make *Microcystis* resilient to change in the environment. Thus, all of these predicted climate changes are expected to benefit *Microcystis* and may lead to the production of more toxic strains. Ecosystem and human health is negatively impacted from the ability of certain strains to produce the hepatotoxin microcystin, among other toxins. Cleanup of *Microcystis* can be economically costly and such disasters can reduce quality of life for residents living near cyanobacteria harmful algal blooms (cHABs). Acidification is becoming a larger problem due to global warming and CO_2 production. The atmospheric CO_2 that is absorbed into water forms carbonic acid (HCO_3^-) which is a weak acid. The results of this reaction lowers the water's pH. In order to understand how different strains of *Microcystis* respond to varying levels of acidification, three strains were isolated from western Lake Erie. We used several strains of *Microcystis* isolated from Lake Erie (LE18-22.4, LE19-59.1, LE19-84.1) and monitored their growth under differing conditions for a period of 15 days. Conditions tested include changes in CO_2 concentration (200, 400, 1000 ppm), nutrients (Urea, NO_3, NH_4) and temperature (18° C, 24° C), respectively. Calculating cell abundance of *Microcystis* can be a long process. *Microcystis* cell density was calculated based on both manual and flow cam cell counts. Flow cam counts were used to estimate the *Microcystis* counts while manual microscope counts were used as a ground truth to confirm calculations. Concentration of *Microcystis* was used to model growth rates based on counts obtained by both methods. Pending results will help us better understand how *Microcystis* growth is affected by acidification and other climate change effects. Understanding how these factors will affect Microcystis and other parts of the microbial ecosystem can help us find ways to curb harmful impacts of Microcystis on human health and the aquatic ecosystem.

Characterization of Individual Carbon-Containing Atmospheric Particles Collected in Wintertime Fairbanks, Alaska

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The subarctic city of Fairbanks, Alaska is highly polluted in the wintertime due to atmospheric inversions, local emissions, and the unique chemistry resulting from cold and dark conditions. The concentration of airborne particulate matter in Fairbanks often exceeds United States federal air quality regulations and presents a danger to human health. The low wintertime temperatures (<-20 °C) in Fairbanks also promote the formation of ice fog, a form of air pollution which consists of ice crystals suspended in the atmosphere. Aerosol particles must be present for ice fog to form at temperatures above -38 °C. However, the chemical composition and morphology of individual atmospheric particles in Fairbanks, including those which may lead to ice fog formation, is not known. To explore the composition and sources of carbonaceous aerosol particles in this polluted environment, atmospheric particles were sampled during the January–February 2022 Alaskan Layered Pollution and Chemical Analysis (ALPACA) field campaign. Size-resolved atmospheric particles were collected using a micro-orifice uniform deposit impactor (MOUDI) utilizing stages 4, 6, and 8 (1.8–3.2 µm, 0.56–1.0 µm, and 0.18–0.32 µm, respectively). Scanning electron microscopy (SEM) images with magnification 2500x–25000x were used to manually classify atmospheric particles according to their morphology to determine the soot fraction in each sample. The number fractions of soot were determined for all analyzed size ranges for select samples across the entire field campaign. To investigate the potential for the collection of ice fog crystals, the sizes of individual particles collected during an ice fog event were measured manually using image processing software. The measured particle size was compared with the expected size range for MOUDI stages 1–4 to study changes in particle size following sample collection, including loss of water due to evaporation or sublimation. The results will improve understanding of aerosol sources and ice fog formation in wintertime urban environments.

Understanding the Rupture Process of the Mw 7.6 2022 Michoacán Earthquake with Distributed Acoustic Sensing

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Mexico City is the most populated city in the Americas. It undergoes significant seismic hazards yet is sparsely instrumented compared to other populated and seismically active regions. The data gap hinders a better understanding of the regional fault system. Our research group installed a Distributed Acoustic Sensing (DAS) interrogator, which measures ground motions with fiber-optic cables, in Mexico City to complement the existing seismic network and collect data in a long-term fashion. On Sep. 19, 2022, a Mw 7.6 earthquake occurred in Michoacán region, approximately 450 km away from the city. The DAS system provides us high-fidelity, ultra-dense, yet unique data for this earthquake.

In this project, we utilize the DAS data to study the rupture process of the earthquake. We follow a recent investigation that uses local DAS systems to achieve a novel 3-D earthquake rupturing image by a higher-frequency back-projection method. We continue to test the limit of DAS in earthquake source studies. We integrate DAS recordings with data from regional stations to investigate the rupture process at different scales. At the same time, we compare and validate the DAS results with results of using global broadband stations. Our results demonstrate the applicability and discuss limitation of DAS in understanding earthquake source. Our project also foreshadows a more enhanced seismic network by incorporating fiber-optic arrays.

Fruits For Understanding Morphological Change Of Araceae In The Fossil Record

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The plant fossil record is crucial for understanding macroevolutionary patterns among diverse plant lineages, offering direct evidence of past diversity. However, understanding systematic relationships between extant and extinct lineages requires thorough documentation of current diversity, establishing a bidirectional feedback for interpreting the fossil record. Araceae, a diverse angiosperm family, has a rich fossil record, yet some fossils are challenging to interpret due to limited comparative data on modern fruit structures. Employing X-ray microcomputed tomography, we studied extant fruits from various Araceae species, spanning most subfamilies and representing nearly every genus. This effort resulted in a novel morphological dataset, aiming to enhance our comprehension of aroid diversity in the past. Morphospace analysis of extant fruits emphasized the significance of oxalate crystals deposited in raphide sacs throughout the seed coat, endosperm, and embryo. When excluding these characters, less likely to be preserved in the fossil record, other morphological traits—such as fruit and embryo shape, seed coat curvature, and micropyle epistasis—emerged as crucial characters shaping morphological changes across extinct and extant Araceae members. This study advances our understanding of aroid fruit structure and provides a morphological framework for integrating fossil fruits into macroevolutionary studies.

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FORMATION OF THE EL LACO IRON OXIDE-APATITE DEPOSIT, CHILE, VIA PRECIPITATION FROM A CO_2 BEARING FE-CL-S-RICH SALT MELT

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Morphology and Chemical Composition of Individual Atmospheric Sea Salt Particles during MOSAiC

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GENOMIC INSIGHTS INTO CARBON UPTAKE STRATEGIES OF *MICROCYSTIS*: IMPLICATIONS FOR TOXIN PRODUCTION AND BLOOM FORMATION IN WESTERN LAKE ERIE

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The Utility of AI Tools in Teaching Earth and Space Science

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Teaching Earth and Space sciences is one of the few subjects in which students cannot ask "When will this come up in real life?" meaning that it is integral for students to understand them. The best way to teach these topics can sometimes be by having students observing them play out, either at the true scale or a much more manageable level. This can be difficult and time consuming. In steps AI and tech tools. These tools span an array of utility within the classroom. From creating labs and tables to utilizing VR and having labs be fully interactive and digital to save time and allow for the most wildly impractical setups to occur thanks to the capability of the digital space. I aim to highlight the pros and cons of these tools, with a review of tools such as Magic School and Prisms. Along with these teaching tools there are some others that provide some supplement in the instances that these suffer some of their shortcomings, or instances in which VR is not an option. Magic School will be the main focus due to the sheer number of uses that it has and the almost limitless potential it offers within the classroom. I will focus on the utility, but highlight the importance of having knowledge within the field as AI is imperfect and gives results that can be confusing or worse flat out wrong. Thus this will be a critical spotlight on the academic and economic implementation of these tools

Sclerochronological Measurements and Growth Data of Pleistocene Scallops

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A regional mass extinction in Pliocene Florida led to a large overhaul in the diversity of Caribbean mollusks. Using isotopic paleothermometry methods on fossil shells such as scallops can reveal information about prehistoric climate and scallop spawning season. The quick growth rates of scallops allow for a detailed picture of temperatures through a Pleistocene year when shells are sampled sequentially in the growth direction. We measured high-resolution $\boldsymbol{\delta}^{18}O_{carb}$ profiles from 4 scallops (2 from both the Caloosahatchee and Nashua Formations) to create subannual records of temperature. We analyzed bulk $\boldsymbol{\Delta}_{47}$ measurements drilled from locations on the shell targeting maximum and minimum $\boldsymbol{\delta}^{18}O_{carb}$ values, inferred to be the seasonal extremes. We converted $\boldsymbol{\delta}^{18}O_{carb}$ values to temperature using $\boldsymbol{\delta}^{18}O_{water}$ values derived from bulk $\boldsymbol{\Delta}_{47}$ measurements and used these profiles to identify the season of spawning. We also identified periods of reduced growth of the scallops through raised growth bands and linked this to seasonality. In all four shells, we found generally smooth $\boldsymbol{\delta}^{18}O_{carb}$ profiles with occasional notable drops, indicating growth of ~1 year. Inferred growth temperatures from $\boldsymbol{\delta}^{18}O_{carb}$ profiles ranged from 7ºC to 15ºC for shells from the Caloosahatchee Formation and from 7ºC to 21ºC for shells from the Buck Hammock Formation. We found that Buck Hammock scallops exhibited a spawning season in spring while Caloosahatchee scallops exhibited fall spawning. The different spawning timing and temperature ranges indicate very different paleoenvironments between the two sites. Our calculated temperatures suggest these Pleistocene paleoenvironments were cooler than modern temperatures in the same region. Interpretations based on faunal changes suggest these units were deposited during a warmer time. This disagreement requires an explanation for this cold bias, which could be an incorrect choice for d18OW, a vital effect in scallops, or something else. Further study will allow us to have a better understanding of the climate backdrop for the regional mass extinction.

Reconstructing Last Interglacial Climate and Ocean Dynamics off of Coastal Massachusetts

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The Last Interglacial (LIG, ~129-116 ka) was the most recent time in Earth's history that globally averaged temperatures were warmer than today. Therefore, studying climate dynamics during the LIG can inform our understanding of climate dynamics in the near future. Proxy and modeling studies suggest that global sea surface temperatures (SSTs) were between 0-2°C higher than today. However, climate conditions vary regionally, meaning that region-specific studies are required to understand regional climate dynamics. SST data is sparse along the Atlantic Coastal Plain (i.e,. U.S. East Coast) - a region particularly susceptible to increased hurricane frequency/intensity and sea level rise due to ocean warming. In this study, we reconstruct LIG SSTs and salinities ($\delta^{18}O_w$) off of Nantucket Island, Massachusetts by applying traditional stable ($\delta^{18}O$) and clumped ($\mathbf{\Delta}_{47}$) paleothermometry to 7 fossil *Mercenaria* (hard clam) shells deposited across 2 units at the Sankaty Head cliff. We conclude that the lower unit likely represents early-stage LIG (i.e., ~130-125 ka) reflecting reconstructed SSTs up to >5°C higher than present-day, while the upper unit represents the beginning of cooling during late-stage LIG (i.e., ~120 ka and after) reflecting reconstructed SSTs similar to present-day. Seasonal SST ranges from both units are similar to the modern seasonal SST range of ~7°C. We find that reconstructed $\delta^{18}O_w$ values are depleted (i.e., less saline) relative to modern values, suggesting that a substantial amount of glacial meltwater mixed with ocean waters. Upper unit $\delta^{18}O_w$ values are more enriched relative to lower unit $\delta^{18}O_w$ values, suggesting that late-stage LIG waters experienced less glacial meltwater mixing after ice sheets had retreated throughout the interglacial. Similar studies can help inform our understanding of future climate and ocean dynamics throughout the North Atlantic.

Impacts of Atmospheric Rivers on Snow Microphysics

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Atmospheric rivers (ARs) are long and narrow corridors of enhanced horizontal water vapor transport that supply mid- and high-latitude regions with anomalously high precipitable water vapor. ARs are associated with enhanced precipitation and winds but are relatively understudied in how they impact snow microphysics. To understand how ARs impact these processes, we evaluate snowfall events coincident with an AR and those events not coincident with an AR. We designate these as "AR snowfall events" and "NoAR snowfall events", respectively. To identify AR snowfall events, we first utilize a MERRA-2 reanalysis-based AR detection algorithm that is specifically tuned to colder and drier regions. We apply this algorithm for two distinct sites: Marquette, Michigan and Hyytiälä, Finland. The AR events and NoAR events are then refined by applying a deep snow detection algorithm to only include events that coincide with snowfall at each site. We analyze and compare the AR snowfall events against the NoAR snowfall events using the instruments at each site. The instrument sites include vertically-profiling radars, scanning radars, and custom NASA video disdrometers that are used to evaluate snow microphysics. We find that AR snowfall is associated with a higher number concentration of and denser particles than NoAR snowfall. By leveraging multiple ground-based instruments, we are able to characterize the differences in snow microphysics between AR and NoAR snowfall, which have implications for retrievals of snowfall from ground-based and space-based instruments.

Characterizing ENSO Teleconnections Impacts on Gross Primary Productivity across CMIP6 Earth System Models

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The El Niño-Southern Oscillation (ENSO) is the dominant mode of interannual variability in the climate system, altering the global distribution of temperature and precipitation. These altered climate patterns impact remote regions, a relationship known as teleconnections. Due to the sensitivity of photosynthesis to changes in temperature, precipitation and radiation, ENSO teleconnections have large implications for the carbon cycle and the magnitude of carbon uptake by terrestrial vegetation at interannual timescales. We quantify the ENSO impact on gross primary productivity (GPP) and identify the physical mechanisms driving the terrestrial ENSO response for different regions around the world. Of the ten CMIP6 Earth System Models we analyzed, most models exhibit consistent global, spatial patterns of ENSO teleconnections with GPP, characterized by a reduced uptake of carbon by terrestrial vegetation during El Niño years. This reduced carbon uptake is primarily driven by a suppression of GPP in the Amazon Basin region due to reduced precipitation. In response to ENSO, the physical climate variations among models are more similar than the GPP response, suggesting an important role for the sensitivities of land processes to changes in physical climate within the ensemble. Three models, IPSL, MIROC, and MPI, exhibit a weaker reduction in GPP in the Amazon Basin region compared to other models due to GPP being more dependent on radiation in these models. These results suggest general agreement among models on the ENSO impact on GPP in key regions, with differences being attributed to the land model response to ENSO-driven climate.

SPATIOTEMPORAL B-VALUE EVOLUTION IN GEOTHERMAL INDUCED EARTHQUAKE SEQUENCES

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Large-scale geothermal projects generate energy by injecting fluids several kilometers into the crust. However, such fluid injections have been shown to induce earthquakes due to pore fluid migration, poro-elastic stress changes, and aseismic deformation. Seismicity associated with fluid injections poses significant hazards, especially in regions without active tectonics. The 2006 Basel injection is one of the most extensively studied geothermal earthquake sequences. Therefore, seismic hazard analyses of the Basel sequence can help constrain hazard in other geothermal sequences as well as future geothermal projects.

One common parameter for evaluating seismic hazard is the b-value. The b-value stems from the Gutenberg-Richter law ($\log_{10}N(M) = a-bM$) and can be used to assess the likelihood of large magnitude earthquakes. On the global scale, a b-value lower than 1 suggests the region may experience more larger earthquakes than the global average. Previous research independently assessed spatial evolution and temporal evolution of b-values in the Basel sequence. Combining the spatial and temporal aspects of previous research, I split the datasets into 20,000 event bins, or "shells", based on distance from injection. Within these shells, I calculated temporal b-values throughout the sequence allowing me to assess spatiotemporal b-value evolution and hopefully extract more information about the sequence than entirely spatial or temporal approaches. Additionally, I utilize b-positive – a less biased parameter than traditional b-value – in my assessment. Spatiotemporal analysis shows high b-values that then experience a significant drop during injection and before the largest earthquake of the sequence. This pattern contrasts with previous research, which concluded a general pattern of high b-values closer to the injection point, and low b-values further out. Future testing will be conducted on other induced seismicity sequences to see if the observed pattern is unique to the Basel sequence and alternative models will also be explored to best capture spatiotemporal diversity in different sequences.

ANALYZING SPATIAL-TEMPORAL ATMOSPHERIC EFFECTS OF LIGHTNING-PRODUCED NITROGEN DIOXIDE

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Nitrogen dioxide is an important chemical in both the stratosphere where it plays a key role in ozone chemistry and in the troposphere where it is a precursor to ozone production. In the troposphere, various combustion processes and, in the interest of this project, lightning strikes produce nitrogen dioxide.

It is well known that lightning strikes can have profound impacts on atmospheric composition through lightning-produced nitrogen oxides.

This project utilizes two datasets in combination to identify spatial transport of NO2 produced by areas of significant lightning strike density.

The ISS Lightning Imaging Sensor (LIS) is a lightning sensor aboard the International Space Station (ISS). The instrument records the time of occurrence of a lightning event, measures the radiant energy, and estimates the location during both day and night conditions. This project will utilize the "Quality Controlled Lightning Imaging Sensor (LIS) on International Space Station (ISS) Science Data V2".

The Ozone Monitoring Instrument (OMI), aboard the Aura satellite, is used to measure many different trace gases and pollutants in the atmosphere. The instrument uses backscattered radiation and specific algorithms to convert measured radiation to pollution concentration. This project will utilize the "OMI/Aura NO2 Cloud-Screened Total and Tropospheric Column L3 Global Gridded 0.25 degree x 0.25 degree V3 (OMNO2d)" dataset to access values of Total Atmospheric Column NO2.

Both sets of data can be accessed and visualized as gridded values on a global map. The LIS provides a flash count of lightning strikes across the globe as well as flash irradiance. OMI provides Total Column NO2 values across the globe in units of molecules per cm^2. This project will analyze a comparison of the two datasets in search of spatial and temporal connections between lightning strike density and the transport of NO2 in the atmosphere.

Analysis of tectonic activity from modern thermobarometry during the late Archean in the English River Subprovince, Ontario Canada

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Earth is the only planet in our solar system with evidence of active plate tectonics. Determining when plate tectonics originated on Earth could provide insight into why Earth is the only planet in our solar system with plate tectonics, if other planets once had plate tectonics, and potentially how life began on Earth due to the interconnectedness of Earth's systems . The late Archean is of particular interest for tectonic research, given the large changes that occurred at that time, such as emergence of the first true continents, compositional changes of igneous rocks, and deposition of the first modern-like passive-margin sediments. These changes have been interpreted as recording the onset of plate tectonics. However, the lack of evidence for Archean subduction and subduction-related rocks makes the hypothesis of modern-like Archean plate tectonics ambiguous. To address whether plate tectonics of any form occurred in the late Archean, I am studying the English River Subprovince (ERSP) which is a 1000 km linear metasedimentary belt in the Archean Superior Province. The Superior Province is interpreted to have formed either by accretion of exotic arc systems in a modern-like plate tectonic system or by large-scale non-plate-tectonic rifting (extension) then reassembly (contraction) of a pre-existing continent above a gigantic mantle overturn. Modern thermobarometry of amphibolite to granulite facie metasedimentary units from the ERSP provide higher constraints on peak metamorphism than previously documented. East of Lac Suel pressure and temperature range from ~790-820°C and ~5.5-6.0 kbar in the north to ~810-860°C and ~4.6-7.0 kbar near the boundary with the Winnipeg River subprovince (WRSP), and in the area near Ear Falls conditions are ~790-860°C and ~3.9-6.0 kbar. Previous estimates from Fe-Mg exchange thermometry provided estimates of ~600°C in the north, and ~725°C at the contact between the ERSP and the WRSP and range of pressure from 3.5 to 6.0 kbar. The new estimates of peak metamorphism are more congruent with peak conditions of other subprovinces within the Superior Province, with the Pikwitonei domain ranging from 8.0-10.0 kbar, the Ashuanipi and Minto subprovinces ranging from 6.0-8.0 kbar, and the Quetico belt reaching 770°C and 6.0 kbar suggesting the Superior Province, as a whole, did not form through plate tectonics.

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USING NEON AND ECOSTRESS TO UNDERSTAND THE ROLE OF DIFFUSE LIGHT ON VEGETATION

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METHODS AND ANALYSIS OF TUSK-DERIVED LIFE HISTORIES OF MALE AND FEMALE MAMMOTHS FROM CHUKOTKA

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Situated on the Chukchi Sea in far eastern Russia, Chukotka was the last part of mainland Eurasia inhabited by the vestiges of a once large population of woolly mammoths. The Chukotka population was also the source of the nearby latest surviving Wrangel Island mammoth population, which went extinct around 5,000ybp. It is critical to analyze the biology of Chukotka mammoths and compare them to the later survivors on Wrangel Island to decipher the complex process of extinction in these iconic animals, in part to better understand threats and population-level patterns of behavior in endangered elephants today. Here we describe eight tusks based on new CT scans, including both males and female mammoths from Chukotka. We first detail our CT methodology, which includes several steps important for interpreting data from tusks whose size and geometry create special problems for CT scanning and reconstruction. From the CT data, patterns seen in female tusks usually differ from those in male tusks in that female tusks show a ~5y cyclic increase and decrease in annual extensional growth, likely influenced by reproductive events. However, not all female tusks showed these cycles clearly; furthermore, thicknesses and volumes of annual increments also do not always follow a straightforward pattern that matches the pattern of annual extensional growth. We explore these complexities, which may be partly derived from the fact that other factors, such as natural fluctuations in water and food availability, can cause variations in growth rate. The use of CT is promising, but especially so in combination with other methods, such as the measurement of levels of hormones from tusk powder at specific times of year in each animal's life, which may provide more direct evidence of specific behaviors. Our preliminary data from Chukotka show reproductive rates from calving intervals similar to other populations of mammoths and to elephants today. More work is needed using these methods to compare more specimens from Wrangel Island to understand the population biology of the last holdouts as the species went extinct.

FINDING CORRELATIONS BETWEEN SEVERE WEATHER STABILITY INDICES TO PREDICT TORNADOES

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Predicting when tornadoes, particularly violent ones, will occur is a task meteorologists are constantly trying to improve, given how difficult it can be with our erratic atmosphere. In the process of trying to predict severe weather conditions across the country, there are a number of stability indices that meteorologists use to determine just how bad conditions will be- including whether tornadoes will occur. These indices include, but are not limited to, the Total Totals Index, the Showalter Index, the Lifted Index, Convective Available Potential Engineering (CAPE), the Significant Tornado Parameter (STP), and the Violent Tornado Parameter (VTP). The purpose of this project is to evaluate the performance of this set of stability indices for a series of severe weather events to determine how well they performed on their own, and then see if their performance is improved when used in combination with each other. The indices, and their combinations, will be tested using severe weather environments which resulted in production of tornadoes of varying intensities (EF0 to EF5). As a control, this analysis was also performed using a set of non-tornadic storm environments.

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RADIOGENIC HEAT PRODUCTION OF METAPELITES: A CASE STUDY FROM THE PRECAMBRIAN BASEMENT OF THE IVANPAH AND SOUTHERN MCCULLOUGH MOUNTAIN RANGES

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Evaluating the reproducibility of coral Sr/Ca in the slow-growing *Siderastrea siderea* among colonies at Los Testigos Island, Venezuela

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THE ROLE OF DIKE TRANSPORT DURING DIFFERENTIATION AND SEGREGATION OF A 2-km HIGH-SiO_2 (>76 wt%) LEUCOGRANITE CAP IN THE ZONED SPIRIT MOUNTAIN GRANITE, SOUTHERN NEVADA

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High-SiO_2 (≥76 wt%) rhyolite (HSR), often characterized by low Sr contents (<20 ppm), only erupts in abundance in regions of continental lithospheric extension. In contrast, HSR rarely erupts in volume at subduction zones and is generally restricted to thin (<20 cm) aplite dikes within arc granitoids. Among the few granitoid exposures that showcase the efficient and massive accumulation of HSR leucogranite are the bimodal (granite-diorite) Miocene intrusions of the Colorado River extensional corridor in Southern Nevada (e.g., Miller et al., 2011), most notably the Spirit Mountain granite. Internal differentiation mechanisms formed a ~2 km cap of HSR leucogranite on top of a ~5 km thick granitoid that zones from a coarse granite down to quartz monzonite, which additionally contains fine-grained dioritic enclaves. Previous studies (e.g., Walker et al., 2007; Miller et al., 2011) focused on the role of compaction within a crystal-rich mush to drive segregation of interstitial melts from the granitic intrusions, leading to the leucogranite cap and the quartz monzonite (cumulate) base. In this study, a modification of this model will be tested to explain the efficient segregation and accumulation of a 2 km thick HSR cap in the Spirit Mountain granite, which is strikingly absent in arc granitoids. Whether differentiation occurred through episodic partial melting driven by the influx of hot (>700°C) H_2O-rich fluid from degassed basaltic intrusions at the base of the Spirit Mountain granite will be examined. Furthermore, the role of pre-existing aplite dikes, which form during late stages of granitoid solidification, during partial melting, will be explored. Specifically, the hypothesis to be tested is that during partial melting, the eutectic aplite dikes melted completely and their ascent drew in partial melt from the surrounding granite. To test this hypothesis, samples of granitoid and aplite dikes will be collected along a 7-km vertical transect through the Spirit Mountain granite and analyzed for their whole-rock major and trace-element geochemistry. This data should elucidate the mechanism of differentiation for the 2 Myr assembly of the Spirit Mountain granite, and the role aplite dikes played in producing a ~2 km leucogranite cap.

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HALOGENATED VOLATILE ORGANIC COMPOUNDS IN AN ARCTIC OILFIELD

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Chemical Composition and Sources of Sea Salt Aerosols over the Central Arctic Ocean: Single-Particle Measurements from a Year-Long Polar Research Expedition

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Evaluating 'Nutrient-Like' Upwelling Proxies in Galápagos Corals

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C and N Cycling at Willow Pond to Determine Viability for Mnomen Reintroduction

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Mnomen (*Zizania palustris* or wild rice) is an annual, emergent wetland grass native to the Great Lakes region. Its history is deeply intertwined with the history of the Anishinaabek people, serving as a staple food and plant of great cultural significance. After years of land use change, introduction of invasive species, and changing environmental conditions due to settler colonialism across the midwest, Mnomen populations have greatly suffered. Building off of previous work from faculty and students at the University of Michigan, our research focuses on the viability of Willow Pond at the Matthaei Botanical Gardens as a site for Mnomen restoration. Our team collected various types of data to determine Willow Pond's viability, including data related to water quality, plant diversity, microbial ecosystems, and sediment chemistry. One of the key factors for fully terrestrial, aquatic, and emergent plants is the availability of nutrients. While any of C, N, and P may be limiting, in aquatic environments it is most often N that is limiting because it first must be fixed to be bioavailable. At the same time high levels of nitrate, often derived from human activity, suppress Mnomen growth. To test for nutrient availability and uptake in Willow Pond, we collected sediments from 5 locations, including 12 samples located close to water quality monitoring stations/vegetation monitoring plots, 17 samples collected from up- and downstream of Willow Pond, and 4 samples from locations closest to the building and parking lot. We measured %C and %N using an Elemental Analyzer and $\delta^{13}C$ using a Picarro Cavity Ringdown Spectrometer, and plotted the results spatially on Willow Pond as well as comparing them to nitrate time series data collected by sondes at four of the sites to assess whether nitrate levels were impacting C/N or $\delta^{13}C$. Deviations from the Redfield ratio for C/N or more positive $\delta^{13}C$ values relative to the typical C3 plant mean of -27‰ may be indicative of environmental stress. Nitrate levels and %N (buried nitrogen) from each of the proposed Mnomen reintroduction sites will be compared to established baselines from the literature to assess site suitability.

Tracking N and C Uptake from Urea in Microcystis Strains

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Harmful algal blooms (HABs) cause severe damage to aquatic ecosystems and threaten human health worldwide. Over the years the Laurentian Great Lakes have experienced increasing threats from cyanobacterial HABs. Lake Erie experiences annual large intense blooms dominated by a toxin-producing cyanobacteria, *Microcystis*. However, there are both non-toxic and toxic-producing strains. Increases in nitrogen and phosphorus, primarily from agricultural runoff, are the primary cause of these HABs. About 60% of the world's nitrogen fertilizer is in the form of urea, which has increased ~100-fold in the last four years. This increase in urea adds nitrogen to eutrophic lake waters. Urea may also contribute carbon to the nutrient cycle. Multiple studies using stable isotope methods found that *Microcystis* use nitrogen from dual-labeled (15N, 13C) urea. Recent research from Krausfeldt et al. 2019 showed one *Microcystis* strain, NIES 834, has the ability to assimilate carbon and nitrogen from urea after 7 days. We also found that NIES 834 incorporated carbon and nitrogen after 7 days but only incorporated nitrogen during a 4-hour incubation. We hypothesize that the 4-hour incubation did not allow for cycling of the carbon molecule, but the 7-day incubation did. Therefore the potential increase in urea in Lake Erie may not be notable in the carbon cycle. Further research is needed to understand the impacts of urea on other Microcystis strains fully.

Oxygenation and Alkalinity Drive the Lacustrine Nitrogen Isotope Record 3.2 Billion Years Ago

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Nitrogen (N) is a crucial element for sustaining life on Earth. Studying N cycling processes throughout Earth's geological history helps us better understand the evolution of life under major biological, tectonic, and geochemical shifts. For example, N processes are sensitive to changes in redox, therefore, N and its stable isotope composition ($\delta^{15}N$) of aquatic sediments can provide insight into primary productivity patterns amidst Earth's gradual, stepwise oxygenation. Previous work has focused on reconstructing the N-cycle with ancient marine sediment $\delta^{15}N$ values, but few studies have examined terrestrial geochemical signals from lakes. To determine whether water column redox conditions in lakes affect geochemical signals preserved in the rock record, we compiled N and organic carbon isotope data ($\delta^{15}N$ and $\delta^{13}C_{org}$) from modern anoxic (n = 26) and oxic (n = 155) lakes. We find an average of $\delta^{15}N$ of 3.52‰ and $\delta^{13}C_{org}$ of -25.89‰ for modern lake sediments, which is lower than previously reported modern marine sediments with an average $\delta^{15}N$ of 6.7‰. The marine values are likely because deep ocean nitrate (~ 5‰) is the primary N-source for phytoplankton in the ocean. In lakes, there are a few trends that appear related to water column oxygenation. We observe thresholds in the isotopic composition of lake sediments with very negative $\delta^{15}N$ values (i.e. < -5‰) only found in wholly oxic water columns and very negative $\delta^{13}C_{org}$ (i.e., < -32‰) or very positive (i.e., > -16‰) values only found in wholly anoxic water columns. These boundaries are associated with anaerobic and aerobic metabolic transformations. To see if the isotope patterns observed in modern lakes hold in ancient lake sediments, we compiled ancient lacustrine sedimentary $\delta^{15}N$ values from 28 stratigraphic units and compared this terrestrial record to marine sedimentary $\delta^{15}N$ reconstructions. We find that while the marine $\delta^{15}N$ record is equivocal with no apparent secular trends and high variability, the lacustrine $\delta^{15}N$ record seems to increase over time from the Archean to the Phanerozoic likely due to the emergence of new N-metabolic pathways as well as the rise of oxygenation in the atmosphere. The Phanerozoic is also pronounced by extremely high positive $\delta^{15}N$ values (> 10‰), reflective of water column alkalinity, further supporting previous use of sediment $\delta^{15}N$ composition as a rough proxy for alkalinity, where values exceeding 10‰ are indicative of alkaline (pH > 9) conditions. Terrestrial aquatic environments, though often understudied, may be better indicators of Earth's global biogeochemical history.

Do changes in spawning season of *Chione* sp. factor into survivorship through the Plio-Pleistocene molluscan extinction?

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A regional extinction event covering the Late Pliocene to the Middle Pleistocene in Florida led to mass faunal turnover within marine mollusk populations, though the exact cause of this turnover remains unconfirmed. Cooling ocean temperatures are often cited as the leading cause, but changing mean temperatures may not be the most influential factor in terms of survivorship. It may have been more important to an individual species whether its thermal tolerances were exceeded during seasonal temperature extremes, which would also have changed along with the mean climate. Subannual $\delta^{18}O$ records can indicate what time of year mollusks spawn, grow, pause growth, and ultimately die, leaving behind a record of physiology and thermal tolerance in their shell material. We collected bulk samples from 22 horizons at Florida Shell Quarry near Charlotte County, Florida from the Caloosahatchee, Bermont, and Fort Thompson Formations. We separated out over 1000 valves of *Chione* sp. including both *C. erosa* (found in older units) and *C. elevata* (found in younger units). *C. elevata* supposedly succeeded *C. erosa* around the time of the Caloosahatchee and Bermont Formations. We measured shell dimensions and generated isotope profiles for 6 or more shells from each unit. In this presentation, I will compare shell size and growth rates across the two species and three formations. I will use $\delta^{18}O$ profiles to determine the season of spawning and compare this across species and formation. I will also use $\delta^{18}O$ to determine and identify changes in seasonal temperature extremes through the section. Climate-driven extinctions are often discussed in terms of changes in mean climate, but individual species may be more sensitive to changes in temperature during key times of year, such as during spawning seasons. Determining the relationship between physiology, climate change, and survivorship could help explain why certain taxa persisted during this regional mass extinction when others did not and could indicate which modern bivalve species are vulnerable to today's rapidly changing climate.

Quantifying the Impacts of Atmospheric Rivers on Snowfall Over Central Greenland

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Atmospheric Rivers (ARs) are long, narrow bands of enhanced moisture that can account for over 90% of poleward water vapor transport above 50°N. This work focuses on their impact on the central Greenland Ice Sheet (GrIS), which is known to be the fastest melting ice sheet in the world and a critical contributor to global sea level rise. This study aims to fill a research gap by conducting a comprehensive assessment of the long-term impact of ARs on snowfall over central GrIS using data from the Integrated Characterization of Energy, Clouds, Atmospheric state, and Precipitation at Summit (ICECAPS) observatory, operational since 2010. While snowfall plays a critical role in the surface mass balance of the GrIS, the complexity of snowfall and its related growth processes can be challenging to accurately model. Additionally, satellite observations of snowfall over Greenland have difficulty with topography and more broadly, are sometimes incomplete or can vary seasonally. By employing the use of ground-based radar and microwave radiometer observations, this research aims to quantify how ARs impact total snowfall, the intensity of snowfall, and snowfall trends in central Greenland. The anticipated findings will offer new insights into how AR-induced snowfall differs from non-AR events, contributing to the improvement of current climate models.

Validating Space Weather Forecasts: An Analysis of Historical Solar Wind Variations Using the AWSoM Model

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The solar wind plays a crucial role in space weather prediction as it can cause or influence various space weather events. This project aims to better understand historical variations in the solar wind to improve space weather prediction models. 180 numerical simulations of the Alfvén Wave Solar Model (AWSoM), the current state-of-the-art model developed at the University of Michigan for solar activity, were conducted to investigate the model performance in the last solar cycle, with one Carrington rotation per year between 2011 and 2019. The model's predicted output was then compared with the OMNI observed solar wind, using a variety of methods to determine the optimal model run for each Carrington rotation. It was determined that the current model is less accurate during periods of high solar activity near 2013. Further analysis was conducted to determine the optimal model parameters for different phases of the solar cycle. Python tools were developed to visualize and analyze trends in the data to better understand the physics behind solar wind variations. We have determined the optimal Poynting flux parameter for modeling historical Carrington rotations in the last solar cycle. The Python tool developed in this project can be used to better prescribe model parameters, most notably the Poynting flux value, for real-time solar wind simulations. It can also be used to validate the AWSoM model and demonstrate its advantages in accurately predicting the solar wind. Improving this model and its usage will be a significant step towards the future of space weather forecasting.

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