Critical Zone Collaborative Network All Hands Meeting

August 6-7, 2025

Lamont-Doherty Earth Observatory | Palisades, NY

WELCOME!

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CUAHSI Code of Conduct

CUAHSI expects all our community members to be respectful, equitable, and inclusive in conduct and treatment of all those engaged or contemplating engagement in CUAHSI's community.

For immediate or serious threat to public safety, contact 911 or locate a house phone and ask for security.
Please report other concerns to CUAHSI staff or leadership.

In Sum

Do:

- Demonstrate fair and honest treatment for all
- Be collaborative
- Make room for diversity - voices, opinions, discussions & decisions

Don't:

- Do not engage in mocking or make jokes that are sexual, racist or of gendered nature
- Do not enforce unwelcome pressure or use power differentials to exert dominance
- Do not demonstrate unwelcome touching

Contact Information:

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CUAHSI Board of Director Chair, Sarah Ledford, sledford@gsu.edu

The full Code of Conduct can be viewed on our website:

Agenda

Day 1

8:00 am Light Breakfast (provided) *Monell Lobby (lower level)*

8:30 am Sign-In *Monell Lobby (upper level)*

9:00 am **Opening Remarks** moderator: Jordan Read *Monell Auditorium*
- Welcome to LDEO - Director of Lamont - Steve Goldstein
- Welcome to CZNet AHM - Jordan Read

9:15 am **Outcomes from the CZ Net Thematic Clusters, Part 1** moderator: Praveen Kumar
(15 minutes each, with ~ 10-min presentations plus 5-min for Q/A)
-Urban Cluster - Claire Welty
-Drylands Cluster - Lixin Jin
-DUST^2 Cluster - Jeff Munroe
-Dynamic Water Storage Cluster - Holly Barnard
-Coastal Cluster - Holly Michael

10:30 am Break

10:45 am **Poster Session 1** moderator: Claire Welty *Monell Lobby (lower level)*
(posters from above clusters)

11:45 am **Discussion** moderator: Claire Welty *Monell Auditorium*

12:00 pm Lunch (provided) *Comer Atrium*

1:00 pm **Activities at Lamont** moderator: Kerstin Lehnert
-Visit to the Marine Core Repository
-Tour of the Lamont Campus
-Hike into Sneeden's Landing

2:00 pm **Outcomes from the CZ Net Thematic Clusters, Part 2** moderator: Lixin Jin *Monell Auditorium*
(15 minutes each, with ~ 10-min presentations plus 5-min for Q/A).
-BigData Cluster - Julia Perdrial
-GeoMicro Cluster - Emma Aronson
-Critical Interface Network Cluster - Allison Goodwell
-Bedrock Cluster - Steve Holbrook

3:00 pm Coffee Break *Monell Lobby (lower level)*

3:15 pm **Poster Session 2** moderator: Emma Aronson *Monell Lobby (lower level)*
(posters from above clusters and others)

4:15 pm **Open Discussion** moderator: Emma Aronson *Monell Auditorium*

4:30 pm **Keynote Talk #1** moderator: Beth Boyer
Kerstin Lehnert - Science-Ready Data for Next Discoveries

5:00 pm **Adjourn**

6:00 pm **Network Dinner at Old '76** (provided)

Day 2

8:00 am Light Breakfast (provided) *Monell Lobby (lower level)*

8:30 am **CZNet Data and Cyberinfrastructure Showcase** moderator: Jeff Horsburgh *Monell Auditorium*
-Resources compiled to date in each major repository for your use (Abner Bogan)
-Discussion of CZNet data sharing challenges (Jeff Horsburgh)
-HydroShare & CUAHSI Resources (Jordan Read)
-EarthChem & Columbia University Resources (Kerstin Lehnert)
-Discussion

9:15 am **Powell Center CZ Synthesis Group Outcomes**
-Kendra Kaiser - "Critical zone as a mediator of hydroclimate-ecosystem asynchrony"
-Lixin Wang - “Towards an integrated understanding of terrestrial evapotranspiration”

9:45 am **Breakout Discussion Groups** *Monell Auditorium and lower lobby*
moderators: Julia Perdrial and Jeff Munroe
-Legacy of CZNet
-spreading of the CZ concept
-science advances
-students/researchers trained
-data
-collaborative publication to be written?

-Future CZ science in the USA
-Areas needing more research
-Areas ripe for cross-site comparisons or synthesis
-Partnerships

11:15 am Break

11::30 pm **Report-outs from Breakout Group Rapporteurs** *Monell Auditorium*

12:00 pm Lunch (provided) *Comer Atrium*

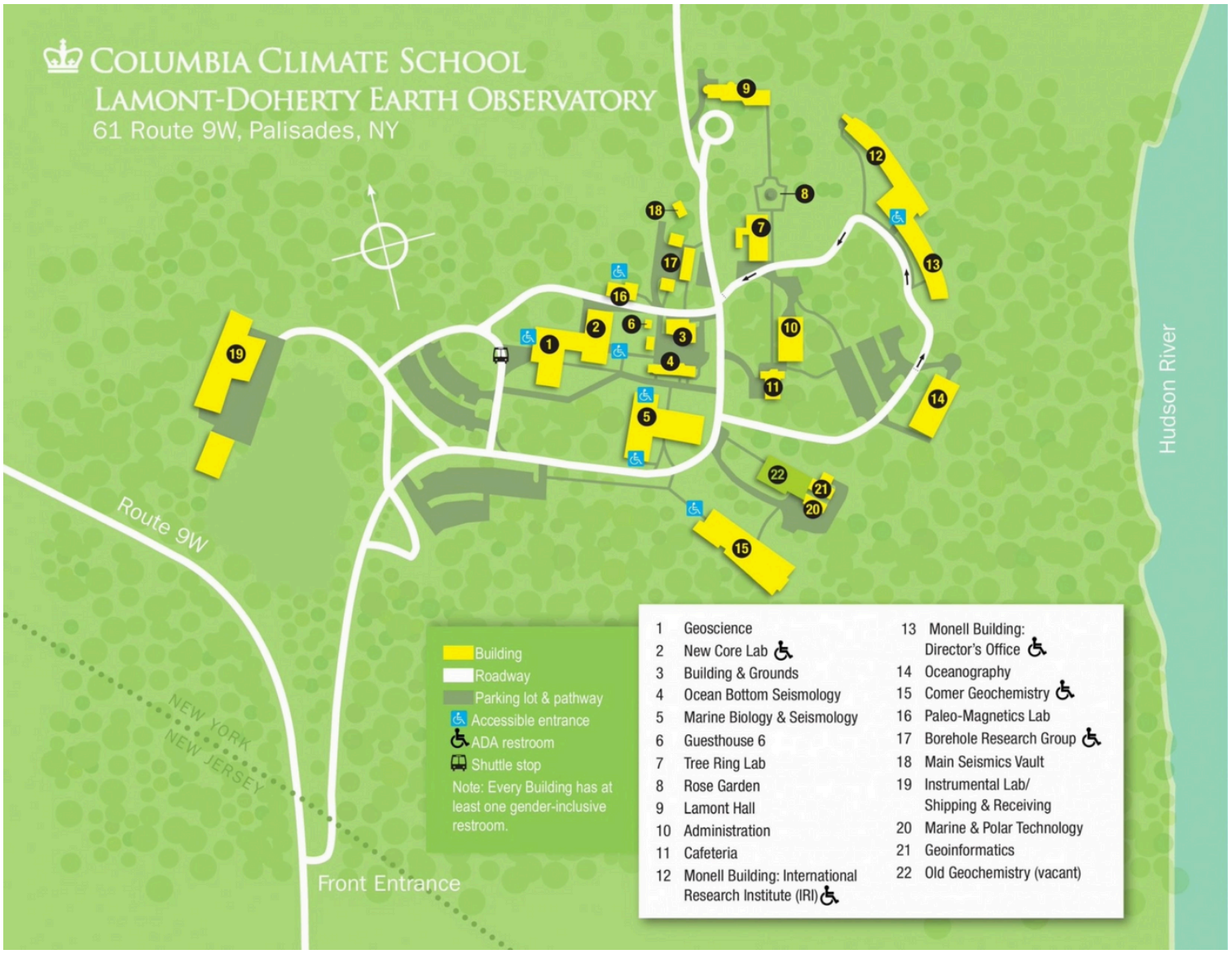
1:00 pm **Keynote Talk #2** moderator: Kerstin Lehnert *Monell Auditorium*
Natalie Raia - Physical Sample Preservation

1:30 pm Networking Break

2:00 pm **NSF Perspectives** Justin Lawrence, Laura Lautz
-CZ Science Investments Past and Future
-QA and open discussion

3:00 pm **Open Discussion and Closing Remarks**

LDEO Campus Map



Monell Building #13	Primary meeting location, Monell Auditorium
Monell Building #13	Light breakfast & coffee, lower lobby
Monell Building #13	Poster Session, lower lobby
Comer Building #15	Lunch, 1st floor atrium

Breakfast and Lunch Menus

August 6

LIGHT BREAKFAST

Morning Pastries and Bagels (not GF)

Seasonal Fruit Salad

Coffee & Tea

LUNCH

Gourmet Sandwich Assortment

Garden Fresh Salad

Dessert Selections

Cold Beverages

August 7

LIGHT BREAKFAST

Morning Pastries and Bagels (not GF)

Seasonal Fruit Salad

Coffee & Tea

LUNCH

House Spice Rubbed Grill Chicken

Quinoa and Black Bean Salad

Garden Fresh Salad

Rustic Bread Assortment (not GF)

Dessert Selections

Cold Beverages

Poster Abstracts

Group 1: Urban Cluster

Investigating mineral dissolution and precipitation in an urban watershed using reactive transport model

Presenter: Kehinde Bosikun

Chemical weathering of silicate minerals releases essential nutrients to natural systems including soils and streams. Additionally, secondary mineral formation, such as kaolinite precipitation, regulates biogeochemical processes and influences soil and water chemistry. Utilizing the reactive transport code, CrunchFlow, we simulated a 1D mineral weathering in the mafic/ultramafic rocks in the Dead Run watershed of Maryland, USA, in order to investigate the relationship between primary mineral dissolution and secondary mineral precipitation in natural systems. The simulation was run for 500,000 years, which represents a reasonable time span for soil formation, with amphibole and anorthite as primary minerals, and goethite and kaolinite as secondary minerals. Hydrologic transport, kinetic and thermodynamic controls were considered. From sensitivity analysis, the flow velocity of infiltrating water, reactive surface area, and presence of reactive gases such as CO2 and O2 are among the key factors influencing mineral dissolution and precipitation. The presence of O2 significantly affects the precipitation of goethite via oxidative dissolution of iron in amphibole. While secondary mineral precipitation shows less sensitivity to variation mineral kinetics, it plays a crucial role in the dissolution behavior of primary mineral, consequently exerting a significant influence on both aqueous and solid-phase elemental compositions. Model results will serve as approximations of the aqueous chemistry at the base of the weathering profile and offer insight to the geochemical conditions associated with pre-urban weathering.

Solute fluxes in urban streams predominantly occur at baseflow: Concentrations outweigh discharge for most solutes

Presenter: Joel Moore

Group 1: Dust^2

The Collectors Tour 2024

Presenter: Jeff Munroe

As part of the DUST^2 project, I maintain a network of 20 passive dust collectors on mountain summits in Utah, Nevada, and southern Idaho. In October 2024, I used the non-stop solo fieldwork to visit all of them as an opportunity for science outreach. Each day, in addition to the gear needed for retrieving the dust and resetting the collectors, I brought along a video camera, tripod, GoPro, and a drone. I used these tools to document what is involved in reaching each of the collector locations, and what the surrounding landscapes look like. At each collector I also recorded a short monolog describing an aspect of the DUST^2 project or related topics. The science communication specialist with DUST^2, Andrew Cassel, then used the footage I provided to produce a 5 to 7-minute video for each of the 20 collectors. These were released rapidly in sequence through the DUST^2 account on Mastodon and the CZNet account on YouTube. The entire series of videos constitutes more than 2 hours of content telling a story about Critical Zone science, the role of dust in how the CZ functions, and the work of the DUST^2 team. To date they have received more than 2600 views making this a broadly successful and lasting science outreach success.

Group 1: Dynamic Water

Greater Sensitivity of Picea engelmanii (Engelmann spruce) than Ponderosa tremuloides (Aspen) to Climate Variability over Six Decades

Presenter: Rahila Yilangai

To understand species-specific responses to climate variability across recent decades, we analyzed radial growth patterns of Picea engelmannii (Engelmann spruce) and Populus tremuloides (aspen) over a 60-year period at Coal Creek watershed, Colorado. Increment cores were collected from mature individuals, the cores were sanded and scanned, and cross-dated using PRISM climate data for the region. Standardized ring width chronologies (RWI) were correlated with monthly temperature and precipitation data across 1955–1984 and 1985–2021, using a 17-month window from May of the previous year to October of the current growth year to capture lagged climate effects. Picea engelmannii showed stronger sensitivity and temporally consistent response to both temperature and precipitation than Populus tremuloides, particularly to previous year climate, with a marked decline in ring width from 1985–2021, suggesting a decline in radial growth under recent warming conditions. In contrast, Populus tremuloides maintained generally weak and temporally variable climate responses across both periods. These results highlight the vulnerability of Picea engelmannii to periodic climatic variability, and the need for interspecific growth-climate analysis at specific time intervals under ongoing climate change.

Sulfate Amendments Reveal Variable Methylation Rates in Beaver-Dominated River Corridors in the Colorado Rocky Mountains

Presenter: Clifford Adamchak

Land managers are reintroducing North American beaver (Castor canadensis) into Western U.S. waterways to restore degraded riparian ecosystems. Beavers create cascades of sequential dams that alter river corridor geomorphology and redox chemistry. These changes can produce conditions conducive to the production of methylmercury (MeHg), a bioaccumulating neurotoxin. Increasing atmospheric mercury (Hg) deposition in the western U.S., combined with beaver expansion, has the potential to dramatically change aquatic biogeochemical cycling and ecological processes, particularly rates of methylmercury (MeHg) production. In this study, we investigated the degree to which beaver activity stimulate Hg methylation rates in montane ecosystems. We present results from water and sediment samples from Coal Creek (Crested Butte, CO) and Trout Creek (Colorado Springs, CO). We quantified total Hg and MeHg concentrations in water and sediment, and sediment

methylation rates. Preliminary results indicate that periodically inundated sediment within a beaver meadow had, on average, higher MeHg concentrations (2.15 +- 3.32 ng g-1) than the stream sediment (0.93 +- 1.51 ng g-1, $p < 0.05$). Additionally, MeHg concentrations in pond surface water (0.322 +- 0.041 ng L-1) and the beaver pond outlet (0.11 +- 0.41 ng L-1) were elevated compared to the inlet (0.05 ng L-1). Although not significant ($p > 0.05$), the results suggest that beaver ponds may be associated with higher production of MeHg, which can be transported downstream. Overall, this study expands our understanding of MeHg production in high-elevation beaver meadows and provides insights for mountain communities and land managers regarding the consequences of continued beaver expansion for water quality.

Estimates of root zone storage capacity and implications for ecosystem evapotranspiration

Presenter: Christopher Heckman

Root zone water storage capacity (SR) sets an upper limit on the water available to plants and is critical for modeling vegetation response to past, current, and future climates. Due to subsurface heterogeneity in soils, roots, and geology, in-situ measurements of SR are infeasible at regional to global scales. Instead, SR is often estimated using a water balance approach—calculating the difference between precipitation and evapotranspiration to approximate water deficits. This method can be applied using diverse datasets, including eddy covariance, satellite remote sensing, reanalysis, and land surface model outputs. However, ecohydrology still has a limited ability to answer: how much uncertainty in SR is too much? To answer this question, we quantified the influence of uncertainty in precipitation and evapotranspiration datasets on estimates of SR. Across 90 FLUXNET sites, site-level SR estimates show an average range of 302 mm and a mean absolute difference of 150 mm across datasets, reflecting uncertainty introduced by differences in data sources. Further, a novel model is used to estimate the sensitivity of evapotranspiration to SR, separating the responses by timescale—daily, seasonal, and interannual. We show that across nine Critical Zone sites, the effects of SRuncertainty on evapotranspiration can vary widely. For example, at Eel River, there is only a 1% change in evapotranspiration estimates from SR values that range from ~500 to 1500 mm, whereas estimates of evapotranspiration can vary from ~60 to 95% of the maximum at Southern Sierra depending on the SR value used. The results quantify the magnitude of uncertainty in SR estimates and contextualize its implications for evapotranspiration across diverse ecosystems.

Group 1: Coastal

Correlating hydrogeologic drivers of the inland movement of Mid-Atlantic marsh-upland boundaries

Presenter: Abigail McGraw

IIncreased sea level rise across the Mid-Atlantic can initiate ecosystem transitions across coastal environments. Salinization of upland environments, increased tidal ranges and saturation, and changes to accretion and subsidence dynamics can all contribute to ecosystem change in low-lying coastal environments. Increasingly salty and saturated conditions in the upland allow the landward movement of salt marsh vegetation, while causing stress and dieback in upland forest environments. The movement of the marsh-upland boundary where migration and dieback occur is frequently used to predict future marsh migration and ecosystem turnover, but limitations in estimating the location of the marsh-upland boundary result in over- and under-estimation of marsh migration. Using remote sensing and field data this study aims to resolve the elevation of marsh-upland boundaries and the drivers impacting them across the Chesapeake Bay, including salinity distribution, soil type, and tidal range. Improving predictions of the location of and drivers affecting marsh-upland boundaries can increase the accuracy of marsh migration estimates under various climate change and sea-level rise scenarios, and contribute to management and conservation efforts in vulnerable coastal ecosystems.

Hydrogeophysical Investigation of Preferential Flow Pathways at a Coastal Forest Site

Presenter: Christopher Terra

Coastal marsh-forest environments are incredibly ecologically diverse biomes that are experiencing significant levels of tree mortality due to lateral saltwater intrusion from sea level rise and vertical saltwater intrusion from flooding due to storm surges and significant high tide events. A coastal marsh-forest in Delaware has been the site of seasonal electrical geophysical surveys since Fall 2023. This project compares seasonal electrical geophysical data with historical groundwater data and deep (5-6 m) soil cores to investigate how potential soil heterogeneities have impacted the site's freshwater-saltwater interface over time.

Stemflow-Groundwater Interactions in Mid-Atlantic Ghost Forests

Presenter: Yu-Ping Chin

Coastal margins along the Atlantic seaboard are undergoing profound transformations due to rising air temperatures, sea level rise, and saltwater intrusion. One consequence is the emergence of "ghost forests," characterized by moribund and dead trees that may disrupt biogeochemical cycling. Among the hydrological processes impacted in these forests, stemflow—the movement of precipitation down tree stems onto the forest floor—plays a critical yet understudied role in carbon cycling. In coastal forests, where the groundwater table is at or near the surface, stemflow may interface with groundwater more readily, possibly introducing unaccounted-for carbon and altering carbon cycling dynamics. This study investigates the dynamic interplay between stemflow and groundwater from both moribund and healthy sweetgum trees (Liquidambar styraciflua L.) in a coastal forest affected by sea level rise. Groundwater wells measured water levels in proximal areas (near the tree trunk, where stemflow enters the ground and affects groundwater) and distal areas (away from the tree trunks, where groundwater is unaffected by stemflow). After each rain event, water levels in proximal areas were consistently higher, with values such as -0.37 m and -0.35 m (relative to ground level), compared to -0.47 m and -0.45m in distal areas, demonstrating stemflow's influence on groundwater recharge. Groundwater influenced by stemflow exhibited elevated carbon normalized UV absorbance at 254 nm ($SUVA_{254}$), indicating higher aromatic carbon levels in comparison to distal areas. Spectral ratios were also higher in proximal areas compared to distal areas, with healthier trees contributing more aromatic carbon than moribund ones. This suggests that stemflow from healthy trees introduces more decomposition-resistant carbon into groundwater, slowing cycling and increasing carbon storage. By elucidating how stemflow-derived carbon impacts groundwater in these vulnerable coastal ecosystems, this research outlines a more macroscopic view of how forest health under climate stress influences stemflow's role in carbon cycling.

Salinity dominates Moisture Content in Soil Water Potential at Marsh-Forest Boundaries

Presenter: Tahmidur Rahman Junayed

Coastal forests and farmlands in the Delmarva peninsula are facing an existential threat from inland intrusion of saltwater due to rising sea level and more frequent coastal flooding. The added salt in the system is causing tree and crop mortality and facilitating inland migration of marsh vegetation. Our study aims to understand how the soil porewater salinity in the root zone is affecting the hydrologic functioning of trees by determining its effect on soil water potential and tree water uptake. We measured soil moisture and salinity at three sites

around the Delmarva Peninsula, USA over a period of 3 years to calculate soil water potential and analyzed temporal variations to identify conditions linked to plant water stress. Low (highly negative) water potential steepens the potential gradient that allows root water uptake. We calculate the two components of water potential – osmotic potential reflecting porewater salinity and matric potential reflecting soil moisture content. We show that the effect of elevated salinity on soil water potential is responsible for variation in water stress at our sites. Comparison of soil water potential to sap flux supports this conclusion. The results highlight the significance of saltwater intrusion as a causal factor in the transition of coastal forests and farmlands to marsh. These results will improve prediction of coastal wetland migration patterns in future sea level rise scenarios, as it links tree stress directly to soil moisture and conductivity conditions.

Evapotranspiration and rainfall effects on post-storm salinization of coastal forests

Presenter: Sergio Fagherazzi

Flooding and salinization triggered by storm surges threaten the survival of coastal forests. After a storm surge event, soil salinity can increase by evapotranspiration or decrease by rainfall dilution. Here we used a 1D hydrological model to study the combined effect of evapotranspiration and rainfall on coastal vegetated areas. Our results shed light on tree root uptake and salinity infiltration feedback as a function of soil characteristics. As evaporation increases from 0 to 2.5 mm/day, soil salinity reaches 80 ppt in both sandy and clay loam soils in the first 5 cm of soil depth. Transpiration instead involves the root zone located in the first 40 cm of depth, affecting salinization in a complex way. In sandy loam soils, storm surge events homogeneously salinize the root zone, while in clay loam soils salinization is stratified, partially affecting tree roots. Soil salinity stratification combined with low permeability maintain root uptakes in clay loam soils 4/5-time higher with respect to sandy loam ones. When cumulative rainfall is larger than potential evapotranspiration ETp (ETp/Rainfall ratios lower than 1), dilution promotes fast recovery to pre-storm soil salinity conditions, especially in sandy loam soils. Field data collected after two storm surge events support the results obtained. Electrical conductivity (a proxy for salinity) increases when the ratio ETp/Rainfall is around 1.76, while recovery occurs when the ratio is around 0.92. In future climate change scenarios with higher temperatures and storm-surge frequency, coastal vegetation will be compromised, because of soil salinity values much higher than tolerable thresholds.

Developing research, infrastructure, and education for earth sciences focused on the coastal critical zone

Presenter: Samrat Dutta

Xavier University of Louisiana (XULA) is a private historically black Catholic university in New Orleans. This primarily undergraduate institution does not have geology or geosciences. We report on building infrastructure at XULA through the ORE-CZ NSF grant to study methane emissions from the wetlands surrounding New Orleans. In doing so, we introduced students to hands-on field work, gave them a better understanding of the Earth's critical zone, and, more importantly, an alternate career opportunity in earth sciences. In three years, we built an undergraduate student-driven research program from scratch to the point of publication. To broaden participation, we introduced elements of research in the classroom, where hands-on outdoors experiments were performed, both to initiate curiosity and to think about earth sciences as a career opportunity. Future works will involve better interaction with critical zone clusters to enhance research and allow students to be assimilated within the network.

Hydrologic Memory and Salinization Risk: Insights from a Four-Year Study of Coastal Storm Surge Events

Presenter: Amirhossein Noori

Storm surge events are increasingly recognized as acute drivers of coastal soil and groundwater salinization, yet their short-term hydrologic impacts remain poorly quantified, particularly across ecotonal gradients. In this study, we examine the responses of groundwater and soil salinity to storm surges within a forest–marsh transition zone on Virginia's Eastern Shore, drawing on a four-year, high-frequency observational dataset. We introduce a salinity storage index (defined as the product of pre-surge groundwater conductivity and groundwater level (GC × GL), with groundwater level referenced to NAVD 88) to represent subsurface salt mass. Our analysis reveals that the magnitude of storm surge-driven increases in groundwater salinity (GC jumps) is strongly and negatively correlated with antecedent groundwater salinity ($R^2 = 0.50$, $p < 0.005$), soil moisture ($R^2 = 0.46$, $p < 0.005$), soil conductivity ($R^2 = 0.45$, $p < 0.005$), and the salinity storage index ($R^2 = 0.76$ at certain sites). Sites characterized by low pre-surge salinity and dry soil conditions exhibited the largest GC jumps, whereas those with saturated soils showed attenuated responses. Salinization dynamics were more predictable in upland forested zones than in low-lying areas near the salt marsh, where residual salinity and geomorphic variability contributed to more complex behavior. These results underscore the critical role of antecedent hydrologic conditions in shaping surge-induced salinization and provide a process-oriented framework for assessing vulnerability across diverse coastal environments.

High Resolution ERT and GPR for Analyzing Root Structure and Water Flow

Presenter: Donald Pesonen

Using small scale scale high resolution electrical resistivity tomography surveys around a tree the infiltration of rainfall into the subsurface as well as the movement of groundwater can be visualized. Utilizing Ground Penetrating Radar the location and size of roots are also able to be mapped. By comparing these two sets of data interpretations regarding saltwater intrusion and how it relates to tree mortality can be explored.

Group 2: Big Data

Drivers and Confounding Factors Influencing Dissolved Organic Carbon and Nitrogen in Continen

Presenter: Isabel Ahsltrom

Streams and rivers provide essential ecosystem services, including drinking water supply and habitat provision. Carbon (C) and nitrogen (N) concentrations, as well as their ratios (C:N), are critical indicators of ecosystem health and aquatic productivity. However, despite regulatory efforts, surface waters remain vulnerable to nutrient and C contamination from both anthropogenic and natural sources complicating water quality dynamics and underscoring the need for deeper insights into the underlying biogeochemical and hydrological processes within the Critical Zone. Addressing this complexity requires data-driven approaches capable of analyzing large and multifaceted datasets.

We leverage existing resources, such as the CAMELS-Chem dataset, which includes catchment attributes, water chemistry, and hydrological parameters from over 500 U.S. Geological Survey sites across the continental U.S. By coupling process understanding with computational approaches, we evaluate long-term trends in C, N, and their ratios to identify and interpret relationships between variables at multiple spatial and temporal scales. This iterative pattern (inductive) and process (deductive) approach helps us untangle complex interactions between disturbances, landscape factors, and water quality.

Multimedia Science Storytelling

Presenter: Andrew Cassel

During the past three years of the CZNet project the Big Data Cluster and the Dust Cluster have both used multimedia content on social networks to tell the story of the Cluster's work. Find out how Cluster scientists collaborated in this effort, the tools used to measure success, lessons learned, and how these platforms can continue to advance Critical Zone science.

HYDROGEM: A Foundation Model for Hydrological Anomaly Detection and Forecasting

Presenter: Ijaz Ul Haq

Anomaly detection in hydrological systems remains a critical challenge for water resource management, flood warning systems, and infrastructure protection. Traditional approaches require site-specific models that fail to generalize across watersheds, limiting their deployment at continental scales. We introduce HYDROGEM ,a foundation model that learns universal representations of hydrological dynamics from 6,000 USGS monitoring stations, enabling zero-shot anomaly detection on previously unseen sites. HYDROGEM addresses the fundamental challenge of extreme heterogeneity in hydrological data through a novel hierarchical normalization scheme coupled with physics-informed scale embeddings. Our architecture synergistically combines Multi-Scale Temporal Convolutional Networks for capturing local discharge-stage dependencies with efficient linear-attention Transformers for modeling long-range temporal patterns and cross-site learning. By incorporating watershed characteristics—drainage area and elevation—directly into the embedding space, the model learns scale-invariant representations that respect mass balance and flow continuity principles.

Pretrained on a decade of hourly measurements comprising over 500 million temporal observations, HYDROGEM employs self-supervised reconstruction learning to identify anomalies without labeled data. The model achieves robust anomaly detection by learning the manifold of normal hydrological behavior across diverse climatic and geological conditions. Our experiments demonstrate that HYDROGEM successfully detects Anomalous events, sensor malfunctions, and unusual discharge patterns in zero-shot settings, while maintaining low false positive rates across sites spanning three orders of magnitude in discharge scales.

The modular design of HYDROGEM facilitates adaptation to downstream tasks through efficient fine-tuning. We demonstrate this capability through preliminary experiments on discharge forecasting and stage prediction tasks. Our work establishes foundation models as a viable paradigm for continental-scale water monitoring, with implications for climate adaptation, infrastructure resilience, and real-time hazard detection.

Exploring a nested deep learning architecture for turbidity forecasting

Presenter: Shaurya Swami

This study presents a nested deep learning framework for turbidity forecasting across tributary networks in the Upper Esopus Creek watershed. By coupling GRU models at

individual tributaries with an LSTM model at the Coldbrook outlet gage, the framework captures both local and integrated turbidity dynamics. Input features for each GRU are selected using Random Forest and SHAP-based methods to tailor predictors to watershed-specific conditions. A multi-objective evolutionary algorithm (MOEA) is used to jointly optimize model hyperparameters with the dual goals of maximizing predictive performance (NSE) and minimizing training time, improving both accuracy and scalability. The model is evaluated across 1-, 3-, 6-, and 24-hour lead times, with special attention to performance under turbidity threshold exceedances. Experiments are conducted on the Vermont Advanced Computing Cluster (VACC), supporting reproducibility and extensibility to larger basins. This study aims to demonstrate how domain-aware deep learning pipelines can support real-time water quality forecasting across complex watershed systems.

Group 2: Geomicrobiology

Critical Zone Connectivity Drives Microbial Community Structure and Function

Presenter: Emma Aronson

The interplay of climatic, biotic, and edaphic factors govern the variability in soil microbial communities across depths, and the resulting influence of microorganisms on biogeochemical functioning of these ecosystems. The field of environmental microbiology seeks to connect microbial community structure to function, but these connections are difficult to translate from a microbial to a landscape and regional scale. The Critical Zone Network (CZNet) has provided a unique opportunity for collaborative research across highly diverse disciplines. The CZNet Geomicrobiology (GeoMicro) Cluster is a highly interdisciplinary multi-investigator group working to investigate soil microbial communities at various depths in five of the former NSF-funded Critical Zone Observatories (CZOs), across the continental US and Puerto Rico. We hypothesized that greater root zone connectivity, precipitation infiltration, particle size, and gas diffusion would reduce variation across depths in redox potentials, nutrient and metal availability, and, importantly, microbial diversity. Based on up to three years of samples and sensor measurements across sites, we now have evidence that connectivity varies not just among sites but within sites. Microbial communities vary with depth in particular with respect to position on the slope and differences in tree root architecture. Here, we present initial data concerning the influence of soil texture and root densities to depth on the soil microbial community structure, alpha and beta diversity. Surprisingly, we found microbial diversity to be more likely to stay similar rather than decrease with depth, particularly when the soil texture is more coarse. These data suggest that soil connectivity drives the microbial functional trends with depth among and within sites.

Group 2: Critical Interface Network

Investigating the Intensively Managed Critical Zone of Central Illinois

Presenter: Erin Bauer

A summary with specific examples of findings and adventures in field sample and data collection over the last ten years.

A Low Power Low Cost Chamber Based CO2 Sensor

Presenter: Brian Saccardi

Soil CO2 fluxes are a key component of the terrestrial carbon cycle. However, these fluxes are notoriously expensive to measure, especially in remote and understudied regions. This is primarily due to the cost of methods currently in use to measure soil CO2 fluxes. To address this gap, we developed and tested a low-cost, lightweight, and portable chamber-based CO_2 flux sensor designed for use in remote environments. The sensors we developed are built from primarily open source and off the shelf components that use minimum power and are designed to be easy to construct and use. We evaluated the sensor's performance at agricultural and prairie sites in Illinois and Nebraska USA, and compare its flux estimates to estimates from gradient-based methods using a variety of sensors. Overall, the results show no significant difference in the mean fluxes between the methods within any given site and our results fall within the ranges seen for prairie fluxes in the literature. The simplicity, affordability, and ease of construction of our design make it a valuable tool for expanding soil carbon flux monitoring networks, facilitating education, and improving our understanding of ecosystem carbon budgets.

Intensive management redefines processes and predictability in the critical zone

Presenter: Allison Goodwell

In the ”intensively managed critical zone” of the U.S. Midwest, engineered drainage, fertilizer application, and soil management enable high agricultural yields, but are interlinked with variable climate conditions and geologic legacies. These perturbations have fundamentally altered CZ dynamics at river-floodplain, root-soil, and land-atmosphere interfaces, and lead to a challenge for predictive understanding. We leverage three high-frequency datasets collected at central Illinois and Nebraska sites to address the hypothesis that human interventions alter CZ processes and predictability. A clustering, dimensionality reduction,

and information theory-based framework reveals distinct temporal ``regimes'' of behaviors in these systems, which are further characterized by their dominant dynamics and joint and individual predictors.

Group 2: CZNet Coordinating Hub

Sample Management for Researchers, Research Programs, and Research Organizations

Presenter: Kerstin Lehnert

This poster will describe new services provided by the System for Earth Sample Registration (SESAR) to individual researchers and research institutions to manage their samples and collections. SESAR provides a cyberinfrastructure that allows its users to upload, edit, and update metadata about samples generated in the field and in the lab, mint IGSNs for these samples, create groups of the samples for are offered to organizations that want to keep track of their samples, make existing collections more discoverable and accessible, and link samples to publications and published datasets.

Promoting Critical Zone Science Literacy Through Education and Outreach Programs

Presenter: Elizabeth Boyer

CZ Net integrates education and outreach (E&O) as core components of its scientific mission, essential to the relevance and long-term impact of environmental research. This poster shares examples of how CZ Net has implemented creative, place-based E&O activities that make complex geoscience accessible and locally meaningful. Key themes include the value of place-based learning, the importance of sustained educator support, and the impact of culturally relevant, community-centered engagement.

Attendees

Steve Holbrook	Virginia Tech	Bedrock
Seulgi Moon	University of California	Bedrock
Julia Perdrial	University of Vermont	Bedrock
Andres Sanchez	University of Southern California	Big Data
Isabel Ahsltrom	University of Vermont	Big Data
Andrew Cassel	University of Vermont	Big Data
Ijaz Ul Haq	University of Vermont	Big Data
Shaurya Swami	UVM	Big Data
Ashlee Dere	University of Nebraska at Omaha	CINet
MARIAN MUSTE	University of Iowa	CINet
Erin Bauer	University of Illinois	CINet

Attendees

Brian Saccardi	University of Illinois	CINet
Allison Goodwell	University of Illinois at Urbana-Champaign	CINet
Neal Blair	Northwestern University	CINet
Praveen Kumar	University of Illinois	CINet
Amirhossein Noori	Boston University	Coastal
Anna Roat	University of Delaware	Coastal
Abigail McGraw	University of Delaware	Coastal
Christopher Terra	Rutgers University - Newark	Coastal
Yu-Ping Chin	University of Delaware	Coastal
Tahmidur Rahman Junayed	Ph.D. Candidate, University of Delaware	Coastal
Matthew Henderson	University of Delaware	Coastal

Attendees

Tracy McMullen	University of Delaware	Coastal
Donald Pesonen	Rutgers University Newark	Coastal
sergio fagherazzi	Boston University	Coastal
Sam Clem	University of Delaware	Coastal
Holly Michael	University of Delaware	Coastal
Samrat Dutta	Xavier university of Louisiana	Coastal
Summer Conley	CUAHSI	CZNet Hub
Kerstin Lehnert	Columbia University	CZNet Hub
Sara Robinson	Lamont-Doherty Earth Observatory	CZNet Hub
Abner Bogan	CUAHSI	CZNet Hub
Elizabeth Boyer	Penn State University	CZNet Hub

Attendees

Jordan Read	CUAHSI	CZNet Hub
Lisa Mucciacito	CUAHSI	CZNet Hub
Jeff Horsburgh	Utah State University	CZNet Hub
Lixin Jin	University of Texas at El Paso	Drylands
Kevin Perry	University of Utah	Dust^2
Jeff Munroe	Middlebury College	Dust^2
Christopher Heckman	Wake Forest University	Dynamic Water
Rahila Yilangai	University of Colorado Boulder	Dynamic Water
Holly Barnard	University of Colorado - Boulder	Dynamic Water
Pamela Sullivan	Oregon State University	Dynamic Water
Clifford Adamchak	University of Colorado, Boulder	Dynamic Water

Attendees

Kamini Singha	University Distinguished Professor	Dynamic Water
Jon Botthoff	University of California, Riverside	Geomicrobiology
Emma Aronson	University of California, Riverside	Geomicrobiology
Mia Maltz	University of California, Riverside	Geomicrobiology and Biogeochemistry
Joel Moore	Towson University	Urban
John Lagrosa	CUERE, University of Maryland, Baltimore County	Urban
Laura Toran	Temple University	Urban
Claire Welty	University of Maryland, Baltimore County (UMBC)	Urban
Kehinde Bosikun	University of Maryland, Baltimore County (UMBC)	Urban
Kendra Kaiser	University of Idaho	Synthesis Working Group

Attendees

Lixin Wang	Indiana University Indianapolis	Synthesis Working Group
Rhea Esposito	NEON	Advisory Committee
Bhavna Arora	Lawrence Berkley National Laboratory	AccelNet

Hotel & Shuttle Bus

DoubleTree Hotel

425 East Route 59, Nanuet, NY, 10954

- On-site parking is available and free
- A full-service bar and restaurant is located on the property - Windsor Grille

A 15 passenger shuttle bus will be making limited trips between the hotel and campus. Seats on the bus are first come, first serve. Schedule below:

August 6th:

- 7:30am departure from DoubleTree
- 8:00am departure from DoubleTree

August 6th:

- 8:30pm departure from '76 House to the DoubleTree

August 7th:

- 7:30am departure from DoubleTree
- 8:00am departure from DoubleTree
- 4:00pm departure from LDEO to DoubleTree
- 4:30pm departure from LDEO to DoubleTree

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Thank you for joining us at the 2025 CZNet All Hands Meeting.