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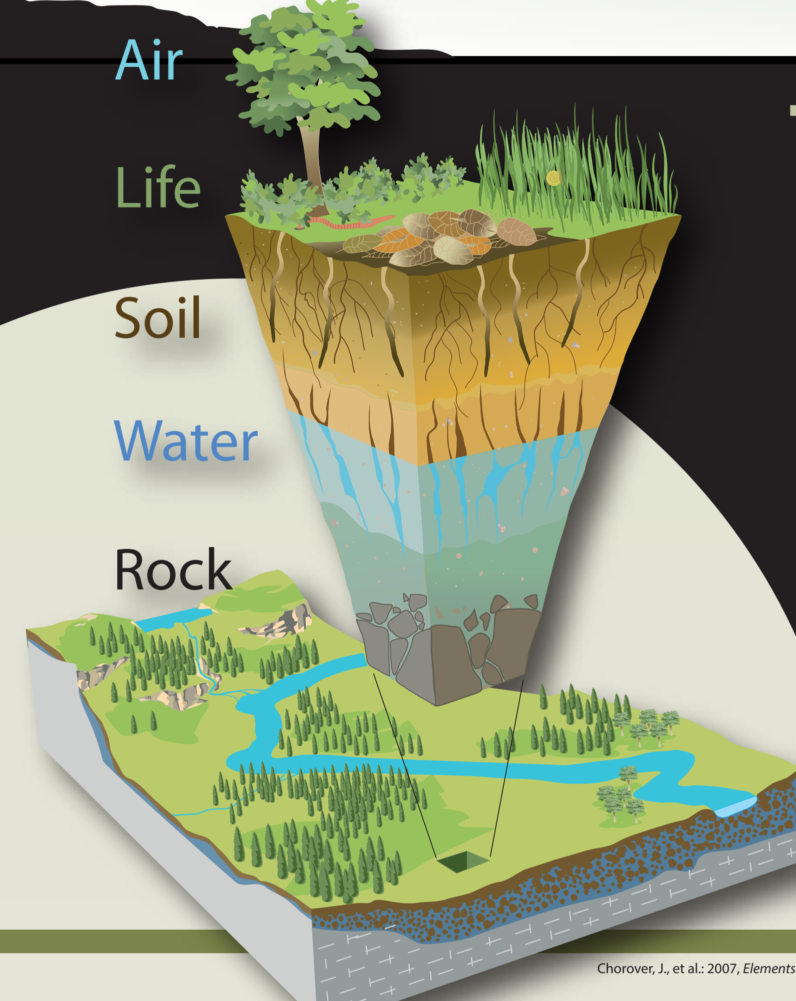
CZO CRITICAL ZONE OBSERVATORIES
U.S. NSF NATIONAL PROGRAM



Chorover, J., et al. 2007, *Elements*, 3, 321.

The Critical Zone: Where rock meets life

The Critical Zone is the living, breathing, evolving interface between rock, soil, water, air, and organisms. It spans treetops to aquifers deep in the subsurface. Complex interactions over time govern Critical Zone architecture and the availability of life sustaining resources.

- Critical Zone timescales range from seconds to eons
- The Critical Zone sustains life
- Humans rely on the Critical Zone, and are significant drivers of modern processes
- Our understanding of Critical Zone processes declines deeper below the surface

The National CZO Program...

A community resource: The Critical Zone Observatory National Office (CZONO) fosters community engagement through logistical support and leadership for network wide activities.

National Office Director: Lou Derry, lad9@cornell.edu
National Office Coordinator: Tim White, tsw113@psu.edu

BOULDER CREEK, CO

Boulder Creek CZO uses the natural laboratory of the Front Range landscape to study the development of critical zone architecture under varying denudation processes, deep weathering front advance, and fluxes of water, nutrients, and sediment in all environments.

Science questions:

- What is the legacy of long-term geologic history in the critical zone?
- What governs the dynamics of key interfaces within critical zone architecture?
- How do slope aspect, microclimate, rock properties, organisms, and rare events control fluxes?
- What feedbacks govern the co-evolution of the CZ and its hydrologic and ecological function?

Boulder Creek CZO · University of Colorado Boulder · INSTAAR

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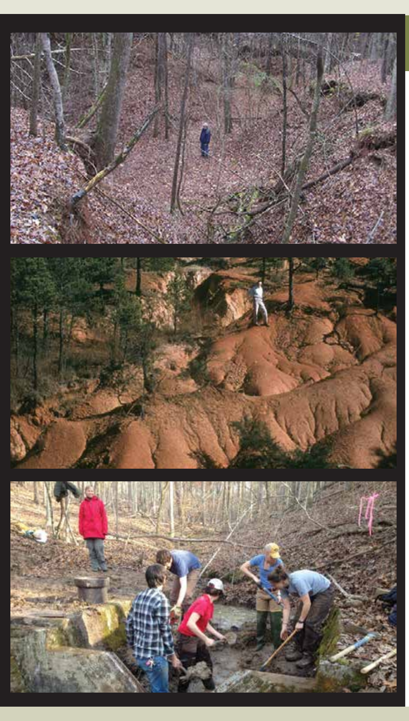
CALHOUN, SC

In North America's Southern Piedmont, the Calhoun CZO organizes its research around questions that build directly on previous site research and span multiple scales of time and space.

Scientific Questions:

- Do land-use change, erosion, and land degradation decouple upper and lower CZ systems by disturbing macroporosity networks of gas and water exchange?
- How rapidly can reforestation re-network the CZ into an integrated ecohydrologic and biogeochemical system?
- How have legacies of severe erosion redistributed and altered minerals and organic carbon on both eroded uplands and in floodplains filled with historic sediment?
- Can human-forced CZs enter new steady states with positive feedbacks and attractors that resist recovery?



Duke University

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CATALINA-JEMEZ, AZ-NM

The CZO comprises an elevation gradient on granite, schist and rhyolite in southern Arizona and northern New Mexico that spans a range in precipitation and temperature representative of the water-limited southwestern US.

Overarching science question:

- How does variability in climate, lithology and disturbance influence CZ structure and function over both short and long time scales? We postulate that CZ structure in a given geomorphic template evolves predictably in response to water, carbon and energy fluxes across the upper boundary.

A nested watershed approach enables real-time measurements from pore-to-pedon-to-hillslope-to-catchment. Observations inform conceptual and numerical models of long-term CZ structure, evolution, coupled dynamics, and their control over the provisioning of CZ services.

The University of Arizona · The University of Utah · The University of New Mexico

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CHRISTINA RIVER BASIN, DE/PA

The CZO spatially and temporally integrates carbon and mineral fluxes in a whole watershed approach to quantifying anthropogenic modification of critical zone carbon sequestration.

Overarching Goal:

To integrate the mineral and carbon cycles to advance our understanding of anthropogenic impacts on carbon sequestration.

Scientific Questions:

- Is carbon sequestration limited at watershed scales by the formation rate of organo-mineral complexes, which is in turn limited by the rate of mixing of fresh organic matter with fresh mineral surfaces?
- Do accelerated soil erosion and mixing associated with agriculture and construction increase complexation and thus sequester organic carbon within a catchment?

Stroud Water Research Center · Minnesota

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EEL RIVER, CA

The CZO focuses on intensive field monitoring in the critical zone to follow watershed currencies: water, solutes, gases, sediment, biota, energy and momentum. These watershed currencies are tracked in the subsurface physical environment and microbial ecosystems into the terrestrial ecosystem, up into the atmosphere, and out through diverse drainage channel networks and mediating aquatic ecosystems.

Research Questions:

- Does lithology control rock moisture availability to plants and therefore resilience of vegetation to climate change in seasonally dry settings?
- How are solute and gas effluents from hillslopes influenced by biota in changing moisture regimes?
- What controls the spatial extent of wetted channels in the channel networks of seasonally dry environments?
- Will changes in critical zone currencies induced by climate or land use change lead to threshold-type switches in river and coastal ecosystems?

Berkeley University of California

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IML, IA-IL-MN

Intensively Managed Landscape (IML)

Science Questions:

- How do time scales of geologic evolution and anthropogenic influence determine the trajectory of Critical Zone structure and function?
- How is the coevolution of biota and the soil affected by intensive management?
- How have the natural patterns of heterogeneity and connectivity across transition zones been changed?
- How do these changes affect the residence times and fluxes of water, carbon, nutrients, and sediment?

Study Sites:

IML-CZO includes the 3,690-km² Upper Sangamon River Basin (IL) and the 270-km² Clear Creek Watershed (IA), & 44,000-km² Minnesota River Basin as a participating site.

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LUQUILLO, PR

Hot spots and hot moments drive key critical zone processes from the bedrock to the atmosphere. The Luquillo CZO is in the USDA Luquillo Experimental Forest in Puerto Rico and focuses on the dynamic drivers of landscape formation, denudation, and carbon storage and loss via soil and stream processes. The CZO exists on adjacent tropical watersheds underlain by contrasting rock types that weather into soils with different physical and biogeochemical properties.

Our specific foci integrate:

- The role of knick points in landscape processes.
- The role of redox fluctuations in biogeochemistry.
- Earth casting models that allow us to explore the role of climate and land use change on critical zone structure and function.
- Sediment transport and stream morphology.

University of New Hampshire

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REYNOLDS CREEK, ID

Most of the world's terrestrial carbon is found in the critical zone, where it is predominantly stored as soil carbon and sensitive to climate change and land management. Despite its importance, soil carbon remains a large source of uncertainty in both carbon cycling and global climate models. Reynolds Creek Critical Zone Observatory (RC CZO) is focused on the quantification of soil carbon and the critical zone processes governing it. The RC CZO is addressing the grand challenges of improving prediction of soil carbon storage and flux from the pedon to landscape scale.

Reynolds Creek Critical Zone Observatory · Idaho State University

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SHALE HILLS, PA

The Susquehanna/Shale Hills CZO is an environmental observatory for the study of the fluxes of water, energy, solutes, and sediments in the Shavers Creek Watershed of central Pennsylvania. The CZO brings together scientists from many disciplines to understand how to measure today's fluxes, and to use models to understand those fluxes and relate them to the history of those fluxes recorded in soils, sediments, and the landscape.

Models span the research from bedrock to the vegetation canopy and from geological to meteorological timescales. The CZO educates students to understand the form and function of the Critical Zone as it operates today and in the past. With models and scenarios of human behavior, we are learning to project how the environment will change into the future.

PennState

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SOUTHERN SIERRA, CA

The CZO explores connections between regolith, water and overlying vegetation in the Sierra Nevada. Spatially distributed, high-frequency measurements of water, nutrient and energy fluxes are central to understanding ecosystem processes across a 2300-m elevation transect.

Overarching Goal:

Goals include predicting water-balance patterns, quantifying feedbacks between hydrologic and biogeochemical cycles, understanding the evolution of soils and landscapes over multiple spatiotemporal scales, and informing resource management.

UC Merced SNRI Sierra Nevada Research Institute

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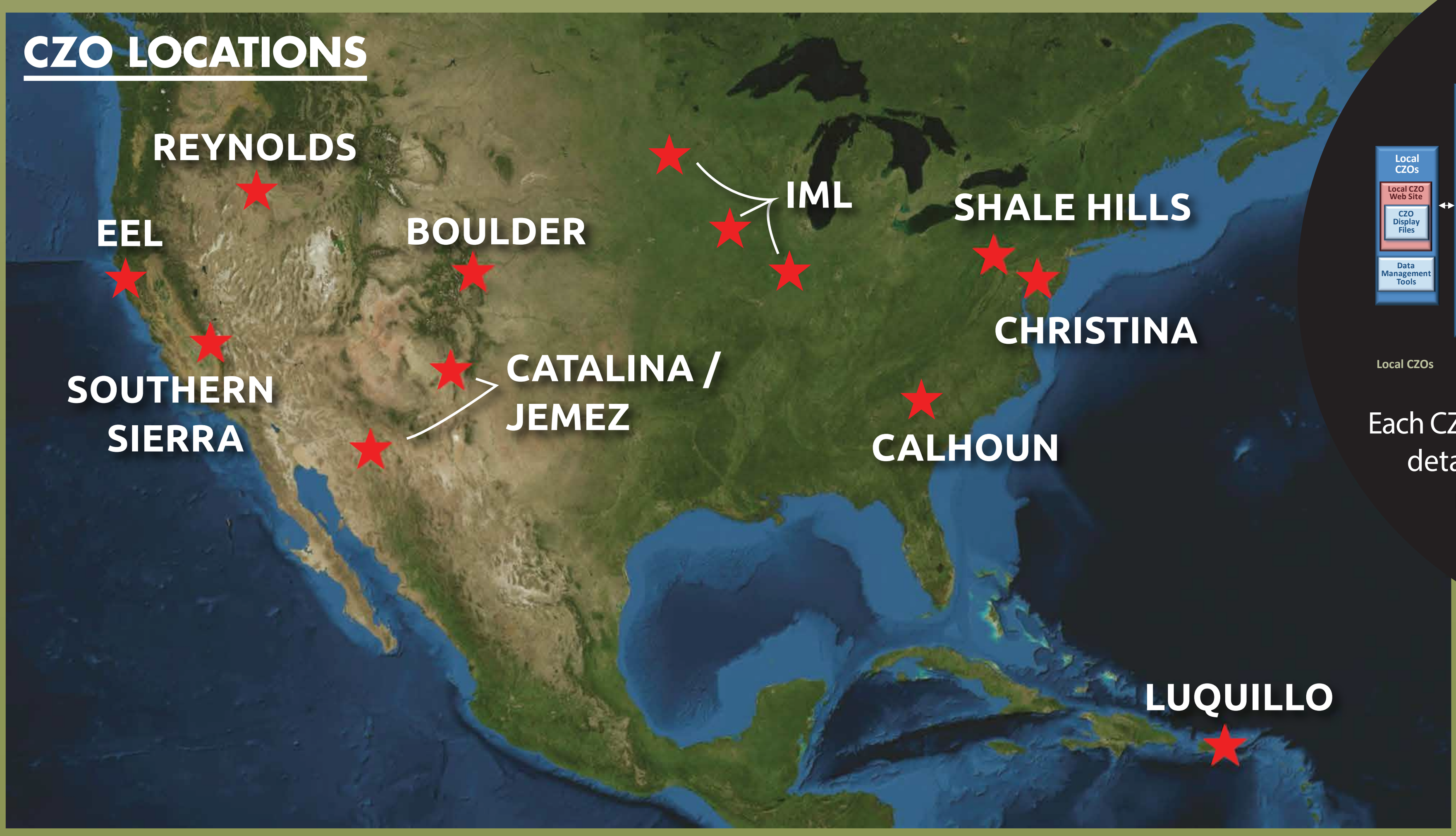
CZO LOCATIONS



CZO DATA

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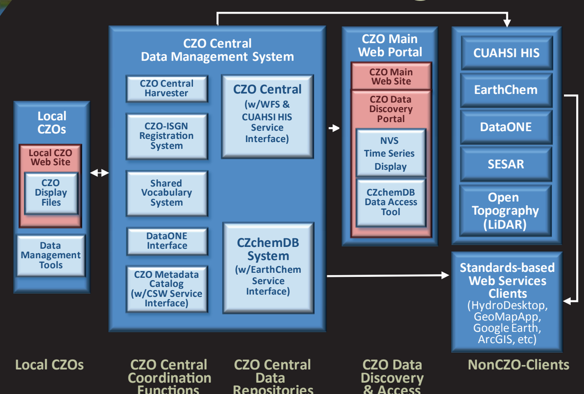

Each CZO is building rich data sets, from detailed topography to hydrologic monitoring to biogeochemical data, available through our connected databases.

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