The Jemez River Basin (NM) & Santa Catalina Mountains (AZ) Critical Zone Observatory (JRB-SCM CZO)

Principal Investigators:

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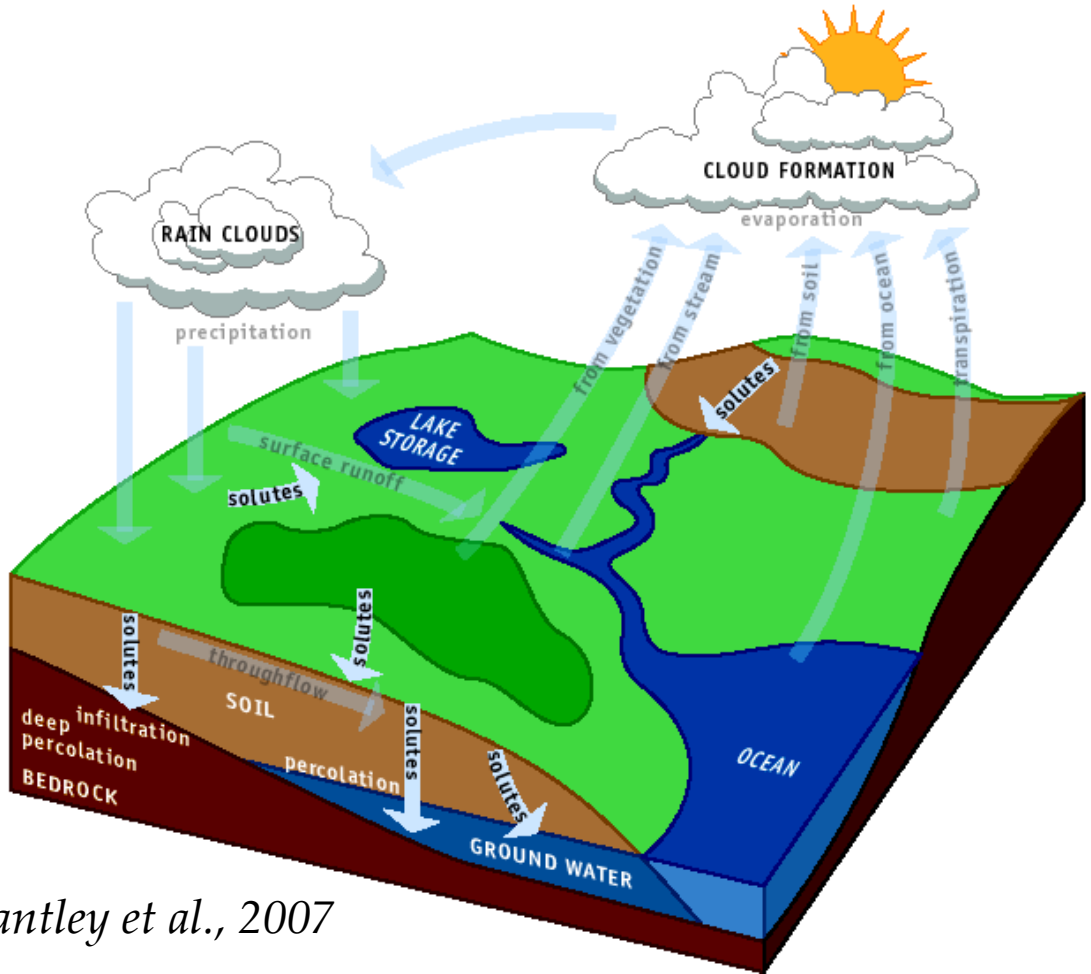
Jon Pelletier (GEOS) – Geomorphology
Craig Rasmussen (SWES) – Pedology
David Breshears (SNRE) – Terrestrial Ecology
Travis Huxman (EEB/B2) – Physiological Ecology
Kathleen Lohse (SNRE → ISU) – Watershed Biogeochemistry
Shirley (Kurc) Papuga (SNRE) – Ecohydrology
Jennifer McIntosh (HWR) – Aqueous Geochemistry
Thomas Meixner (HWR) – Catchment Hydrochemistry
Marcel Schaap (SWES) – Soil Physics

What is the Critical Zone?

The external terrestrial layer extending from the outer limits of vegetation to the lower boundary of groundwater, inclusive of all liquid, gas, mineral and biotic components.



Brantley et al., 2007

As defined by the National Research Council in the "BROES" Report (2001).

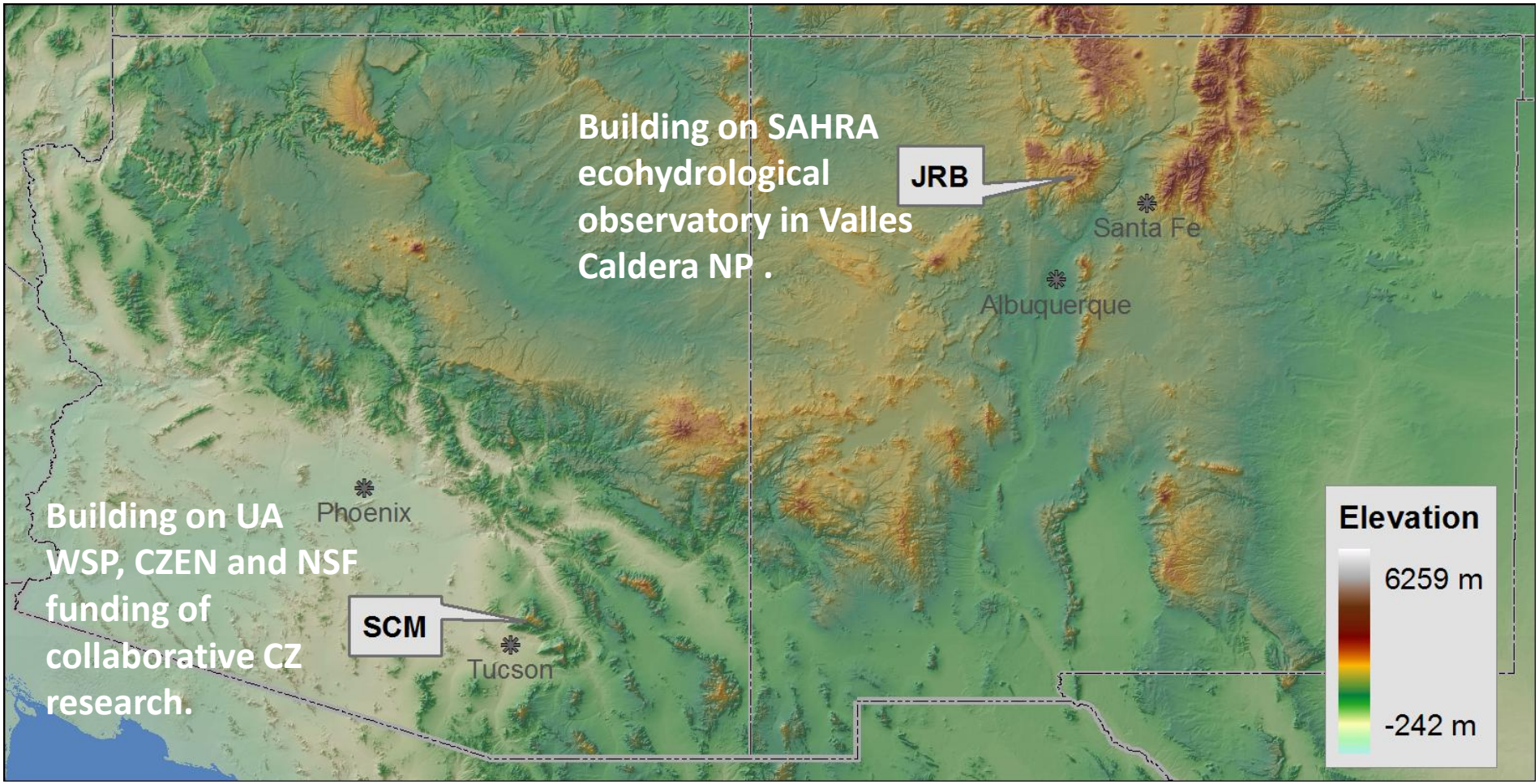
$$CZ = f\{\text{hydrologic, geochemical, geomorphic, pedologic, ecologic}\}$$

NSF EAR 06-588: Critical Zone Observatories (CZO)

- *"Processes occurring at and near the Earth's surface do not operate independently, but the extent to which they are coupled, and at what temporal and spatial scales, remains largely unknown."*
- Need for natural laboratories, where terrestrial processes and systems can be studied through detailed field observations and in situ measurements.
- Techniques from several disciplines must be coordinated to collect data sets that are spatially dense and temporally extended.
- Address the integration and coupling of earth surface processes as mediated by the presence and flux of fresh water.

JRB-SCM NSF funding 9/1/09 – 8/31/14

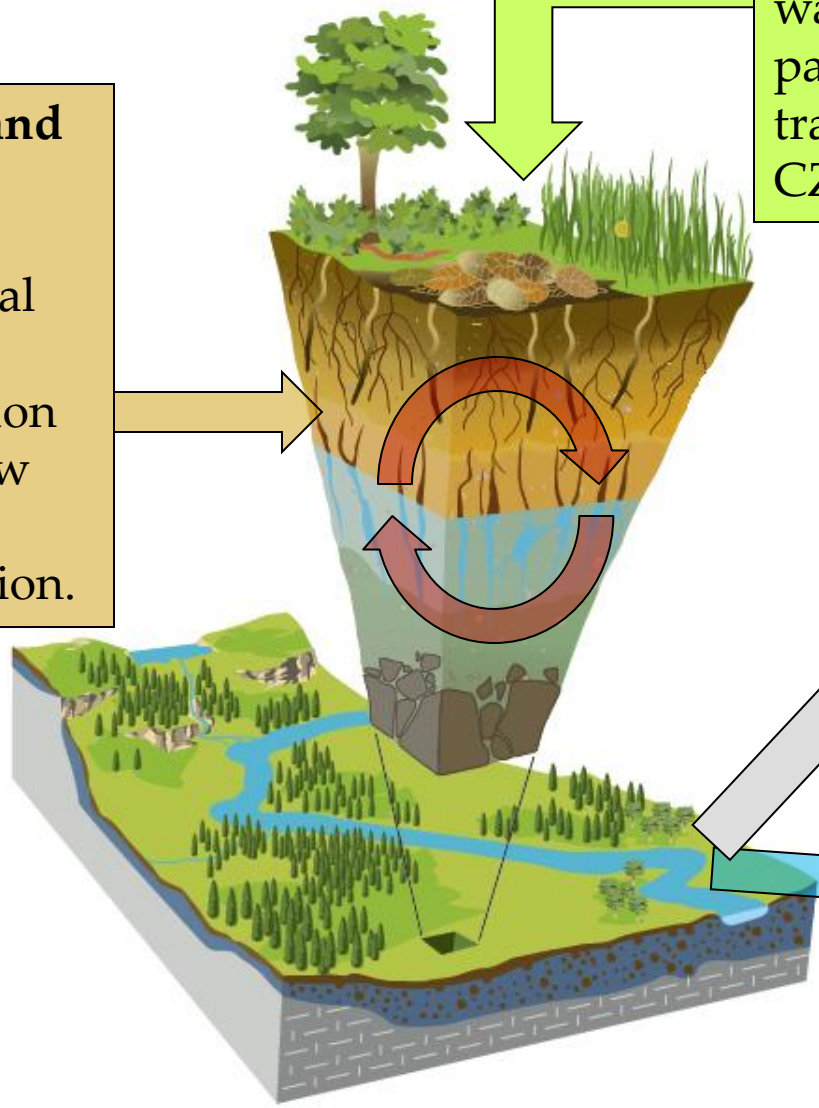
CZO locations in Jemez River Basin (NM) and Santa Catalina Mountains (AZ) span a large climate & water cycle parameter space in the semi-arid southwestern US



Open system CZ conceptual model

Energy and Matter Influx: Radiation, water, and carbon partitioned and transported along CZ gradients.

Energy Storage and Structural Organization: Secondary mineral formation, SOM stabilization, pedon horizonation, flow path formation, landscape evolution.



Dissipative products: Physical and chemical denudation, Sediments, solutes, gases, latent heat.

Overarching research question that guides JRB-SCM CZO design

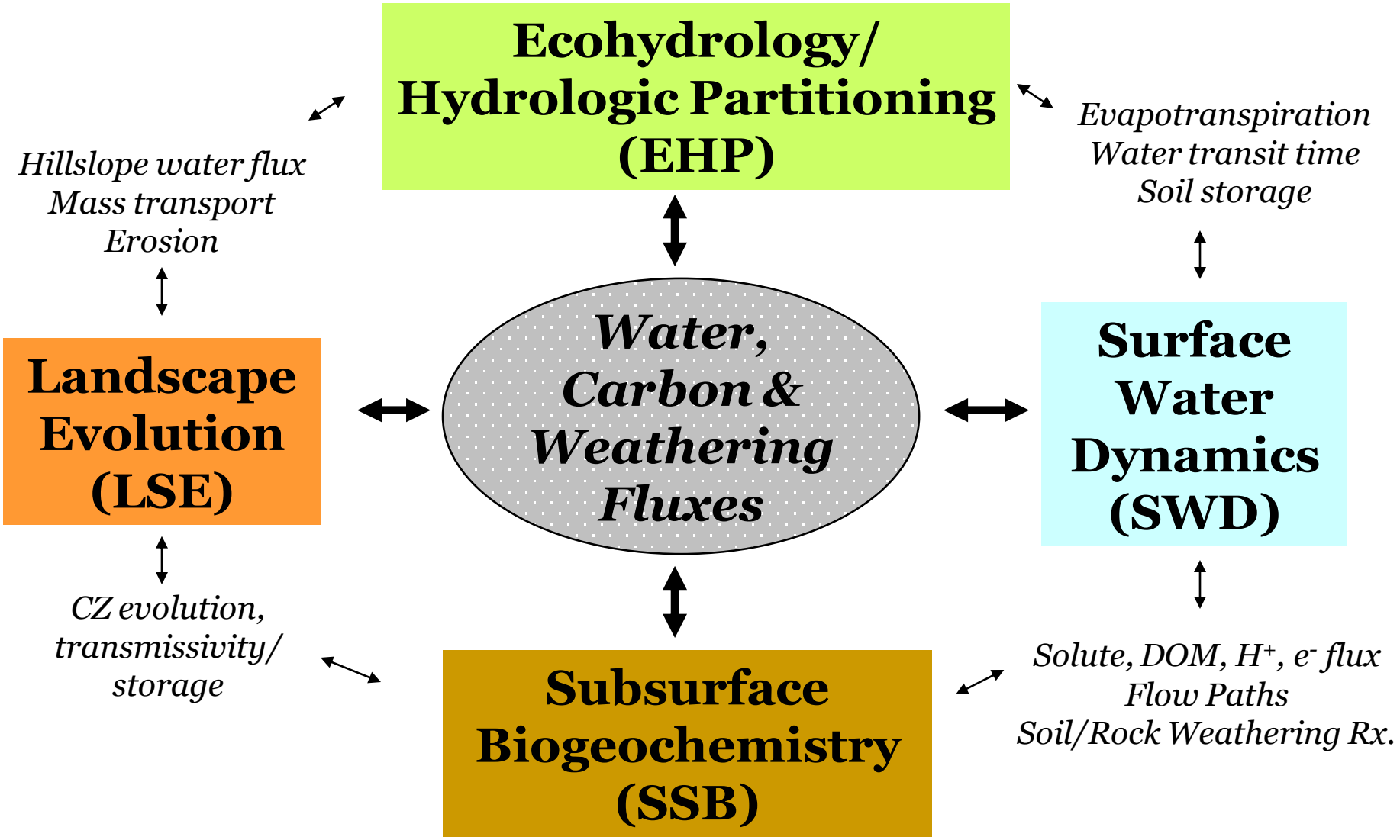
How does variability in climate and lithology influence CZ structure and function over both short (*e.g., hydrologic event*) and long (e.g., *landscape evolution*) time scales?

<u>Primary integrated foci:</u>

- Partitioning and mean transit times of water and carbon
- Distribution of total chemical weathering into mineral transformation *versus* chemical denudation
- Topographic measures and rates of fluvial and hillslope erosion
- Pedogenesis, hillslope relief, valley density

JRB-SCM CZO research integrates four cross-cutting science themes

(each linked by CZ process coupling, energy & mass transfers)



Research Approach: *Model* ⟷ *Measure*

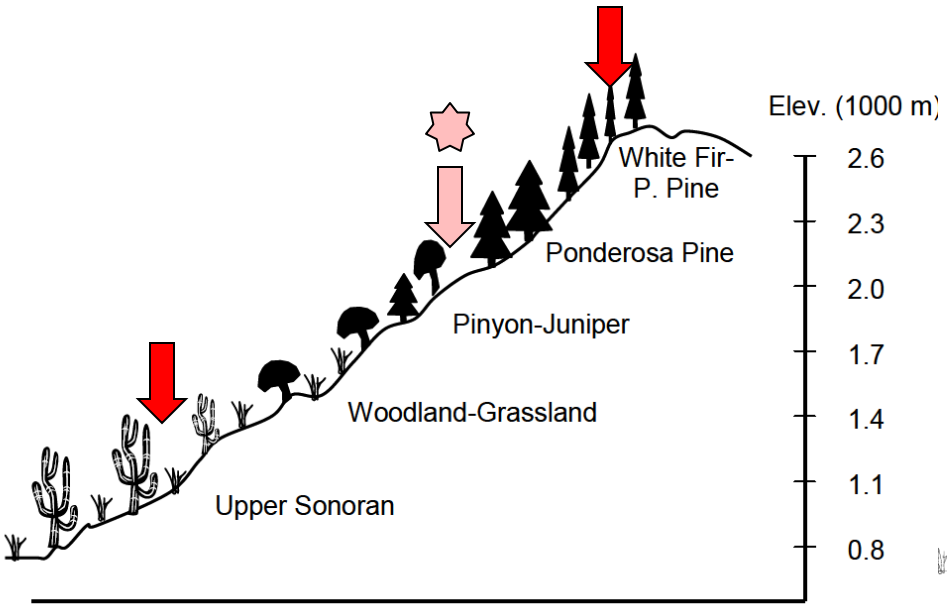
- Critical Zone Modeling
  - Empirical (Energy/Climate Based, EEMT)
  - Process coupled (hydrology-biogeochemistry-geomorphology)
- Synoptic sampling along EEMT gradients at both JRB and SCM
  - Vegetation (ANPP, community structure/composition)
  - Soil (morphology, mineralogy, chemistry, microbiology, SOM)
  - Bedrock (morphology, mineralogy, chemistry)
  - Surface water (element/isotope chemistry, DCOM)
- Installation of nested hillslope and zero order basin (ZOB) observatory instrumentation
  - Eddy flux towers
  - Sap flow monitors
  - Soil solution samplers (spatially-distributed chemistry, isotopes at sub-catchment scale)
  - Soil moisture, water potential and temperature probes
  - Flumes and ISCO samplers

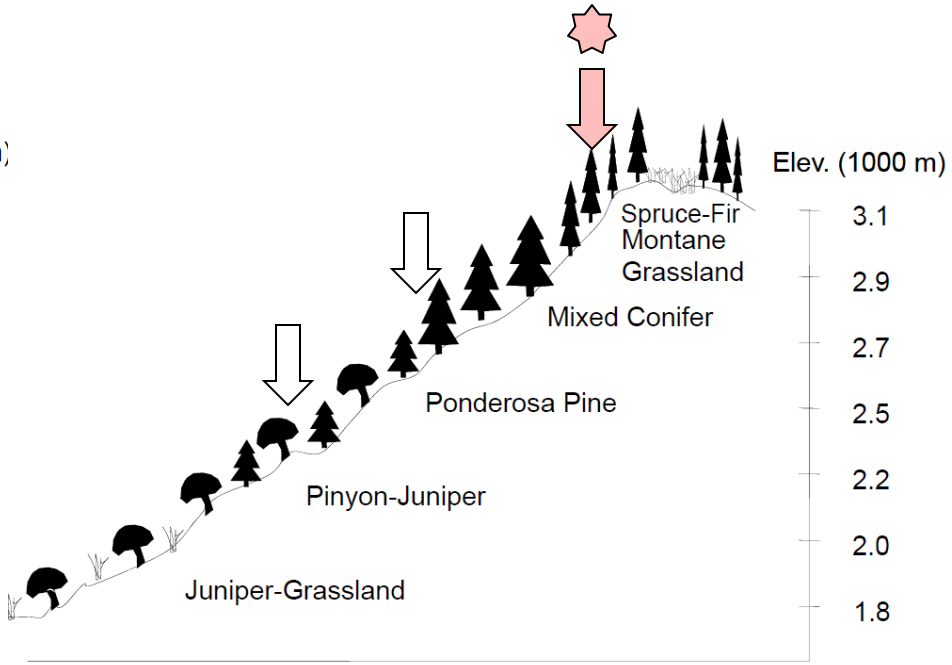
SCM Elevation Gradient

MAT: 18 to 11 °C
MAP: 0.4 to 0.8 m y^{-1}
Lithology: Granite & Schist
Watershed: Santa Cruz

JRB Elevation Gradient

MAT: 11 to 3 °C
MAP: 0.4 to 0.8 m y^{-1}
Lithology: Rhyolite
Watershed: Jemez River

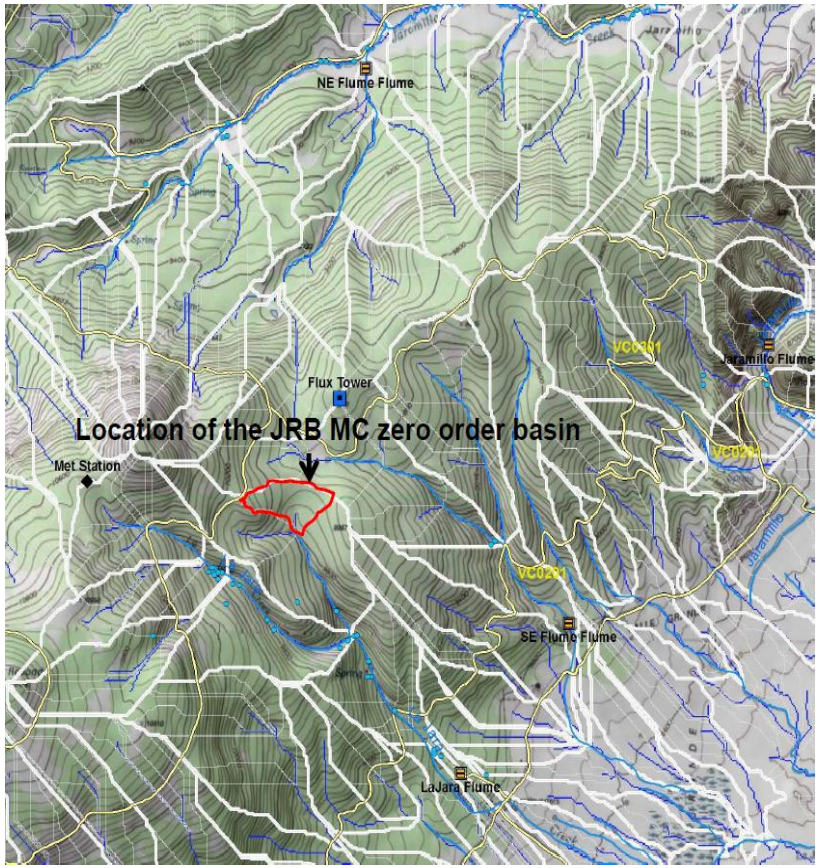


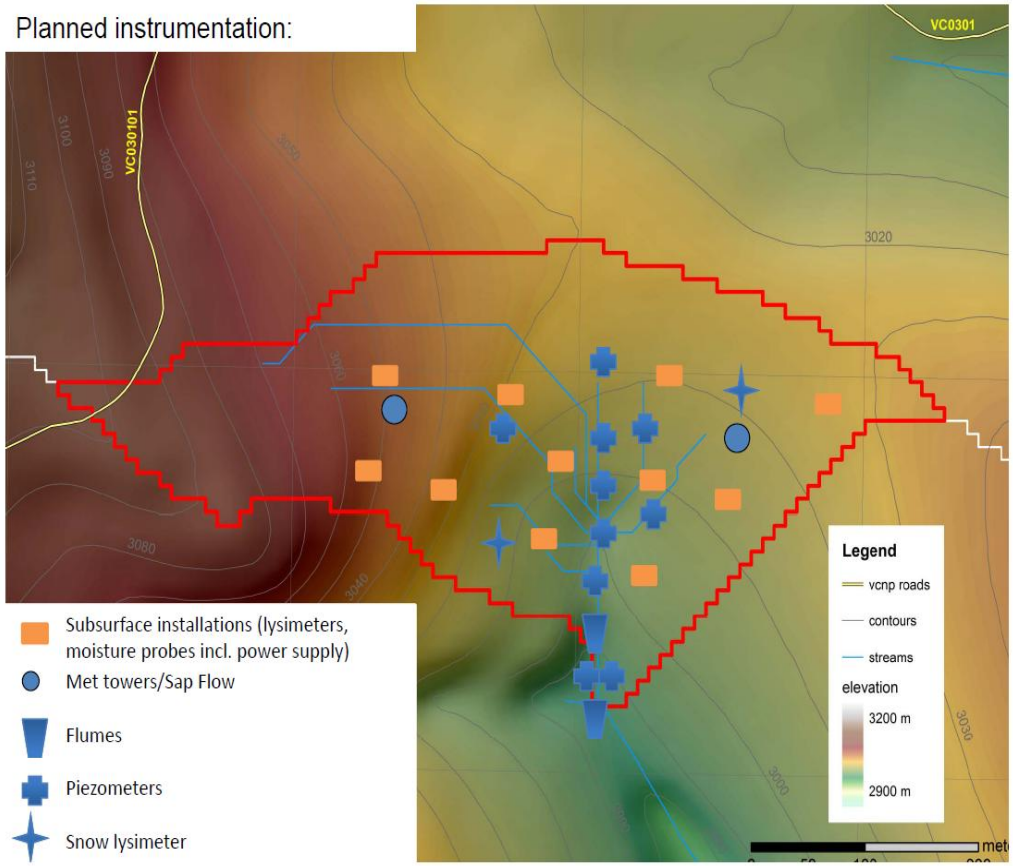


Instrumented Zero Order Basins (ZOBs)

Existing This year Planned

Mixed conifer ZOB (JRB)





Installations of equipment to begin September 24:

- Sapflow and Meteorological Stations
- Wick and Prenart tension soil solution samplers
- Decagon 5TE sensors for soil moisture, temperature and EC
- Decagon MPS-1 soil water potential sensors
- Decagon EM50R dataloggers
- Flumes and stream gages

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  - University of Arizona
    - School of Earth and Environmental Sciences
    - School of Natural Resources and Environment
    - Biosphere 2
    - Water Sustainability Program
    - Semi-Arid Hydrology and Riparian Areas (SAHRA)
  - **VISIT us at www.czo.arizona.edu**