Research focus. The Jemez River Basin – Santa Catalina Mountains (JRB-SCM) Critical Zone Observatory was established in 2009 as part of the National CZO Program funded by NSF. It comprises a pair of observatories – in northern New Mexico (JRB) within the Rio Grande Basin and in southern Arizona (SCM) within the Colorado River Basin – that together span gradients in climate, lithology, and biota representative of much variation found in the larger southwestern US. The focus of research is on the influence of climate and lithology on critical zone structure, function and evolution along elevation gradients. The JRB is situated north of Albuquerque in north central New Mexico and involves close collaboration with research staff at the Valles Caldera National Preserve, which serves as a location of intensive study. The SCM is located north and east of metropolitan Tucson, in the Coronado National Forest of southern Arizona.

Our focus is on understanding how 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. We are addressing this issue using a theoretical framework that quantifies system inputs in terms of effective energy and mass transfer (EEMT, MJ m^{-2} yr^{-1}).

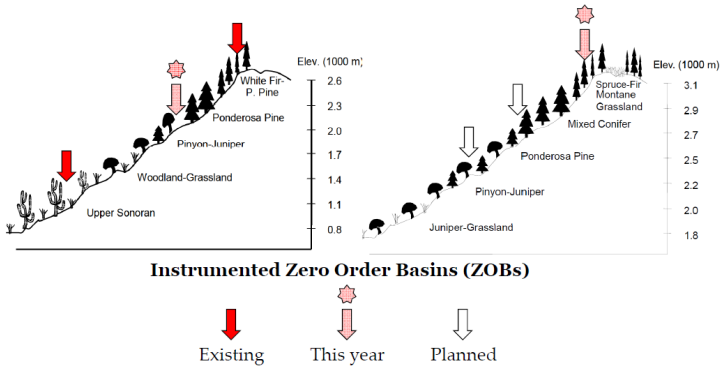
Science questions currently being addressed include:

- *How does variability in energy input and related mass flux influence critical zone structure and function?*
- *How do feedbacks between critical zone structure and the cycling of water and carbon alter short-term hydrologic response and long-term landscape evolution?*

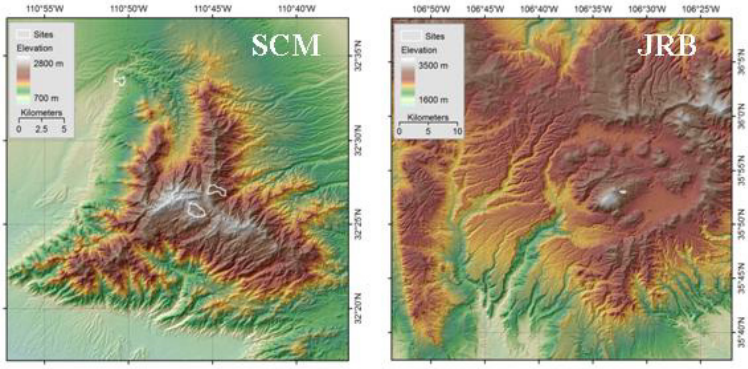
Land use/vegetation. Our instrumented zero order basins span six ecosystems, viz Upper Sonoran Desert, Desert Woodland-Grassland, Pinyon-Juniper, Ponderosa Pine, Mixed Conifer and Montane Grassland. There is a recorded history of logging in the Valles Caldera National Preserve (VCNP) that ended in the 70s, and both sites experienced regular wild fires. Both VCNP and SCM have restricted recreational use, e.g. hunting and fishing.

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



The JRB-SCM comprises elevation gradients in granite, schist, and rhyolite lithologies that span a range of ecosystem types.



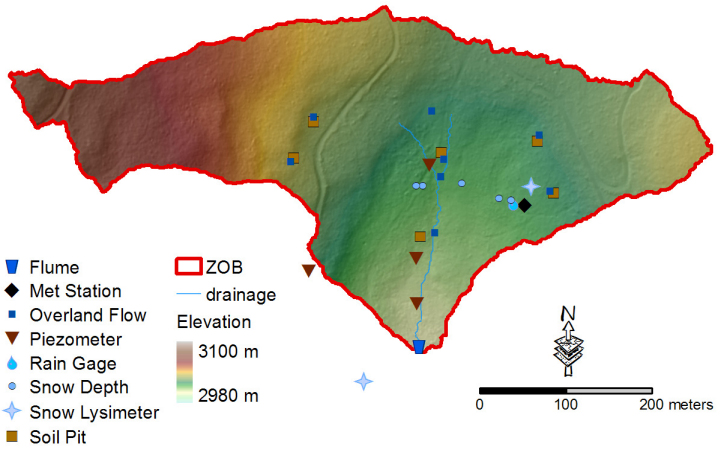
Digital elevation maps of the SCM (a) and JRB (b).

Geology and soils. SCM bedrock is dominated by pre-Cambrian and Tertiary aged granites and granodiorite, in combination with Paleozoic aged metamorphic rocks such as schist and quartzite. Terrain is steep and rugged. Soils are shallow at low elevation (< 25 to 50 cm depending on landscape position) where weathering depth is limited by hot, dry climate conditions and deeper (ca. 50-100 cm) at high elevation where cool, wet conditions prevail. Schist soils are more deeply weathered, finer in texture, and contain more organic matter than granite soils.

JRB bedrock is dominated by silica-rich extrusive volcanic rocks: rhyolitic tuff, rhyolite, andesite, dacite, and silica-rich volcanic ash. Instrumented catchments in JRB are located primarily on rhyolitic tuff, which facilitates formation of deep soils (70 to > 200 cm depending on landscape position). The thick soil cover corresponds with a relatively diffuse landscape structure. Tuff-derived soils exhibit substantial clay accumulation in the subsurface. Upper soil horizons contain appreciable volcanic glass and kaolin, whereas subsurface horizons have less glass and more smectite.

JRB Climate. The Jemez River Basin is located in the transition zone between the southwestern desert and the Rocky Mountains. With increasing elevation, mean annual temperature decreases from 18 to 11 °C and mean annual precipitation increases from 0.4 to 0.8 m yr^{-1}. Climate for the mixed conifer zero order basin (ZOB, below) which is a subject of intensive collaborative study can be characterized as semiarid, continental and montane. The MAP, 790 mm, falls mostly in winter snow and summer monsoon rain (July and August). MAT is 4.9 °C with average lowest and highest temperatures of -8.7 °C and 21.2 °C, respectively.

JRB Experimental Zero Order Basins (ZOBs). Three ZOBs are being instrumented for study in the JRB. The high-elevation ZOB lies on the east slope of Redondo Peak, the dome in the center of Valles caldera (35°52'56"N 106°32'8"W). The basin is south oriented with dominant southwest and southeast facing slopes, moderate slopes with average value of 9.5 degrees (0.3 – 27.1 degrees), and elevation ranges from 2986 m to 3103 m. The area of the ZOB is 0.14 km^2.



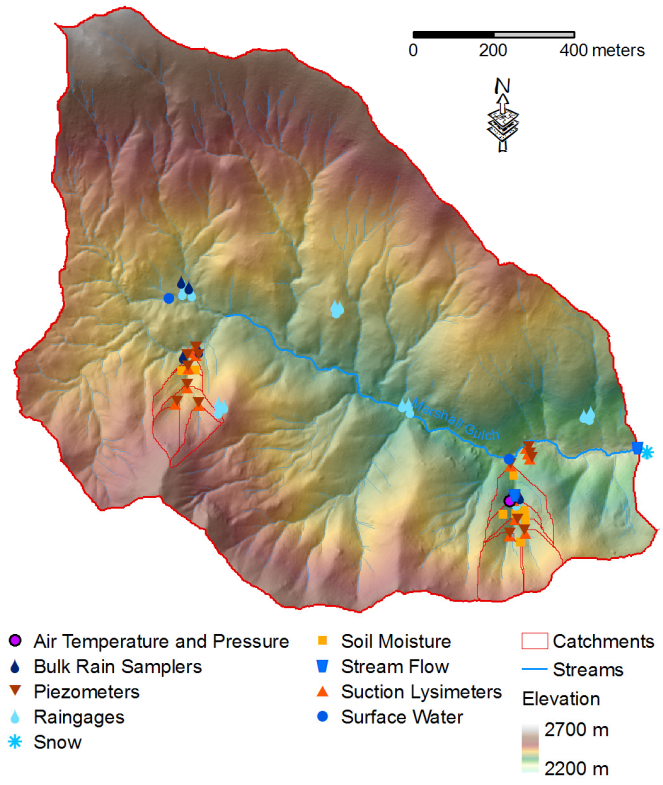
Instrumentation. At each location (JRB and SCM) field equipment is being deployed in ZOBs to measure water, carbon and energy stores and fluxes across the critical zone. Instrumentation includes eddy covariance flux towers, sap flow sensors, phenocams, weather stations, rain gauges, rain water samplers, streamflow flumes, snow depth sensors, snow melt lysimeters, shallow groundwater piezometers, soil moisture and soil temperature probes, soil water tensiometers, and soil water solution samplers.

Signature data types. All level 2 time series, sample and spatially distributed data can be accessed at http://www.czo.arizona.edu/data.html. The most current level 1 data are available by request. Investigator-specific data are available as per the NSF data policy.

Research highlights. Isotope hydrology, rare earth element geochemistry, pedogenic studies, and landscape evolution modeling all confirm that weathering trajectories at the ZOB scale exhibit strong dependence on lithology in similar water/energy (EEMT) regimes.

SCM Climate. The climate of the Marshall Gulch catchment (below), a focus of study within the SCM, can be characterized as semi-arid and montane. Mean annual precipitation is 750 mm, delivered mostly during intense summer monsoon (July and August) and as winter snowfall. Average temperature is 9.4 °C and the average lowest and highest temperatures are -3.8 °C and 23.9 °C, respectively. In 2009, the total precipitation was 456 mm, minimal temperature -6.7 °C and maximal temperature 27.7 °C.

SCM Experimental ZOBs. One of three experimental sites is Marshall Gulch (below, 1.54 km^2) located southeast of Mount Lemon, the largest peak of the mountains (32°25'45"N 110°46'0"W). Two V-shaped ZOBs (schist (SC) and granite (GC)) lie within the Marshall Gulch catchment. Both ZOBs are north oriented with relatively steep slopes (3.2 – 56.4 degrees) which have north, northeast and northwest facing aspects. Elevation ranges from 2311 m to 2476 m for SC basin (area is 0.03 km^2) and from 2379 m to 2516 m for GC basin (area is 0.05 km^2).



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The Jemez River Basin and Santa Catalina Mountains CZO involves co-investigators, collaborators, and students or postdocs from several campuses. **To join the CZO community, contact one of the PIs or Tim White (CZO coordinator):** tsw113@psu.edu