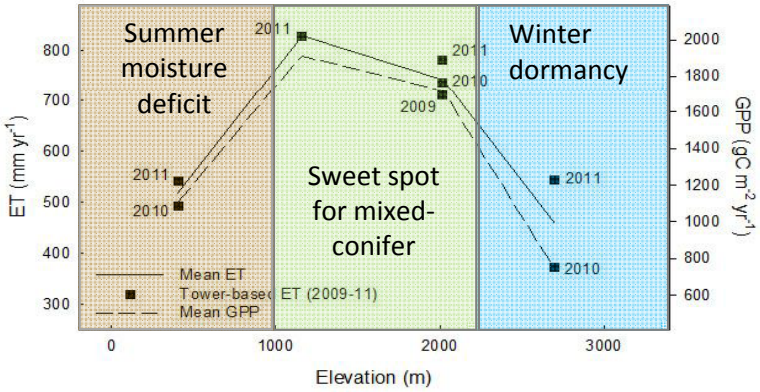
Vegetation-Water-Regolith Interactions

Southern Sierra Critical Zone Observatory

Research question. One research theme at the Southern Sierra Critical Zone Observatory (SSCZO) addressed how climate and regolith properties control the distribution, density and activity of vegetation. Two specific questions were: i) what are evapotranspiration (ET) patterns, and ii) what controls these patterns.

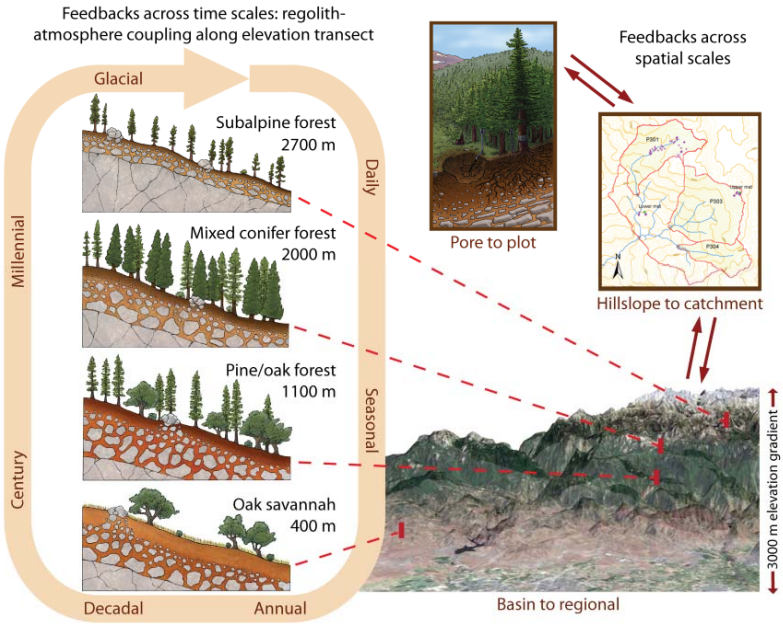
Findings. The deeper regolith (below mapped soils) is critical for supplying water for ET and baseflow in streams for 5 or more months each year. Mid-montane forests largely avoid summer water stress despite a 5-month dry season. Over one-third of annual ET at the 2000-m site comes from depths below one meter. Geophysical surveys and subsurface samples confirm that the water-holding capacity of weathered regolith at these depths is sufficient to account for the deeply sourced ET. Regolith development and plant access to water stored at depth are critical for sustaining high rates of ecosystem production and ET within the mixed-conifer zone.

Experimental design. We are using altitudinal differences to understand how vegetation density and type control ET and runoff . Moreover, we are using a space-for-time approach to understand how an upslope redistribution of vegetation with climate warming influences ET and runoff. Detailed, sustained observations at four sites along an elevation gradient provide information on the relationships between weather and climate, regolith properties, hydrology, plant physiology and vegetation type. The broad scope of measurements, large number of sites involved, and long-duration of observations required is only possible within a program like the CZO.



Relationships between elevation, evapotranspiration (ET) and gross ecosystem CO_2 exchange (GPP).

Cross-disciplinary perspective. The critical zone is a highly cross-disciplinary system, and a multi-disciplinary team and perspective are needed for rapid progress. The SSCZO is ideal for sorting out interactions among climate, the distribution and function of vegetation, and hydrology. Climate exerts direct effects on hydrology by controlling precipitation and potential evaporation, and indirect effects by controlling regolith formation and vegetation type, density, and activity. Likewise, regolith properties and hydrology are key controllers of plant distribution and function. Conversely, vegetation distribution, density and physiology influence meteorology, weathering, regolith development and water and element balances. These findings about ET directly impact decisions and policy around managing forests and water supplies.



The SSCZO elevation gradient that includes 4 flux towers extends from 400 to over 2700 m on the western slope of the Sierra Nevada.

More information: http://criticalzone.org/sierra/

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