Does timber harvest have a measurable effect on the water cycle in the southern Sierra Nevada, California?

No, it did not. But we did learn a bit more about resiliency of the forest to moisture stress.
Response of forest evapotranspiration to multi-year drought in the southern Sierra Nevada, California

1. Introduction to Southern Sierra Critical Zone Observatory (CZO)
2. Water-balance measurements
3. Evapotranspiration results

Acknowledgements:
– National Science Foundation: Critical Zone Observatory Program
– U.S. Forest Service Pacific Southwest Research Station
SSCZO site location, gradients & infrastructure

4 instrumented sites along steep climate gradient: 12°C, 60 km

Co-located w/ USFS watershed research site:
8 headwater catchments
~ 100 ha each

Lower SSCZO site proposed for NEON core

Field work & bunk space

Open access to data – encourage collaboration
SSCZO conceptual model

Feedbacks across time scales: regolith-atmosphere coupling along elevation transect

- Glacial
  - Subalpine forest 2700 m
- Millennial
  - Mixed conifer forest 2000 m
- Century
  - Pine/oak forest 1100 m
- Decadal
  - Oak savannah 400 m

Feedbacks across spatial scales
- Pore to plot
- Hillslope to catchment
- Basin to regional

3000 m elevation gradient
Oak savannah
- E 400 m
- $T_{ave}$ 14.4°C
- P 500 mm
- $H_{tree}$ 11 m
- 25% tree cover

Pine/oak forest
- E 1100 m
- $T_{ave}$ 10.9°C
- P 850 mm
- $H_{tree}$ 29 m
- 63% tree cover

Mixed conifer forest
- E 2000 m
- $T_{ave}$ 8.9°C
- P 1100 mm
- $H_{tree}$ >30 m
- 53% tree cover

Subalpine forest
- E 2700 m
- $T_{ave}$ 4.1°C
- P 1200 mm
- $H_{tree}$ 22 m
- 31% tree cover

snow

rain
Evapotranspiration (ET) across an elevation transect

Mid-elevation forests show neither summer nor winter shutdown:
- deep rooting & resiliency to moisture stress
- warmer canopy-level temperatures despite snow

Goulden et al., 2012
Providence Creek – main SSCZO instrument cluster

- 3 headwater catchments with stream gauges & water-quality measurements
- 2 met stations
- 60-m tall flux tower
- 60-node wireless embedded sensor network
- 214 EC-TM sensors for volumetric water content
- 113 MPS sensors for matric potential
- 57 snow-depth sensors
- Meadow piezometers & wells
- Sap-flow sensors
Water balance on regolith – change in storage

\[ \Delta S = \text{Precipitation} - \text{ET} - \text{Streamflow} - \text{Deep drainage} \]

For this talk, storage includes snowpack, shallow regolith & deeper regolith.
Timber harvest summer 2012: uneven-age thinning & removal of 15-20% of biomass
Precipitation at mixed conifer site (Providence Creek)
Streamflow at mixed conifer site (Providence Creek)
Monthly evapotranspiration at mixed conifer site (Providence Creek)
Monthly **dry season** evapotranspiration at mixed conifer site (Providence Creek)
Evapotranspiration in oak/pine forest

(No tree harvest)

Cumulative ET, cm

Water year day

1100 m elevation
Evapotranspiration in oak savannah

(No tree harvest)

Cumulative ET, cm

Water year day

400 m elevation

2010
2011
2012
2013

(No tree harvest)
Dry season change in storage for 3 elevations

![Chart showing dry season change in storage for 3 elevations from 2009 to 2013. The chart compares Oak Savannah, Pine/oak forest, and Mixed conifer storage changes over the years.](chart.png)
Summary of findings: ET & ΔS

Mixed conifer, 2000 m elevation
80 cm subsurface storage
Multi-year resiliency to moisture stress
Effect of timber harvest masked by dry year

Pine/oak forest, 1100 m elevation
75 cm subsurface storage
One-year resiliency to moisture stress
Higher ET than mixed conifer

Oak savannah, 400 m elevation
30 cm subsurface storage
Limited resiliency to moisture stress
How resilient to moisture stress will the mixed-conifer forest be in WY 2014? How will it respond?