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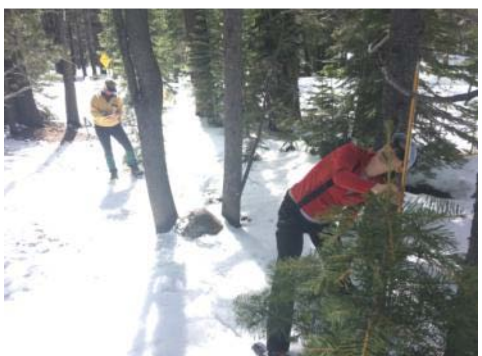
Natural Resources and Environmental Science

Sagehen Creek Experimental Watershed: Measuring Hydrologic Stores and Fluxes at the Northern-End of the Sierra Nevada







Outline

- Why Sagehen?
  - Unique questions
  - Long-term measurements
  - Current infrastructure
  - Testing of novel observations
  - Remote sensing
  - Modeling
- Future directions
  - Tree transpiration and growth
  - ET measurement
  - Process-based modeling

Why Sagehen: Unique questions

- Are forests able to utilize earlier snowmelt water inputs for transpiration and carbon uptake?
- What trees are most sensitive to changing snow water inputs?
- How does deep groundwater buffer hydrologic partitioning and streamflow to drought?
- How does forest thinning alter snow accumulation and persistence?

Sagehen Watershed

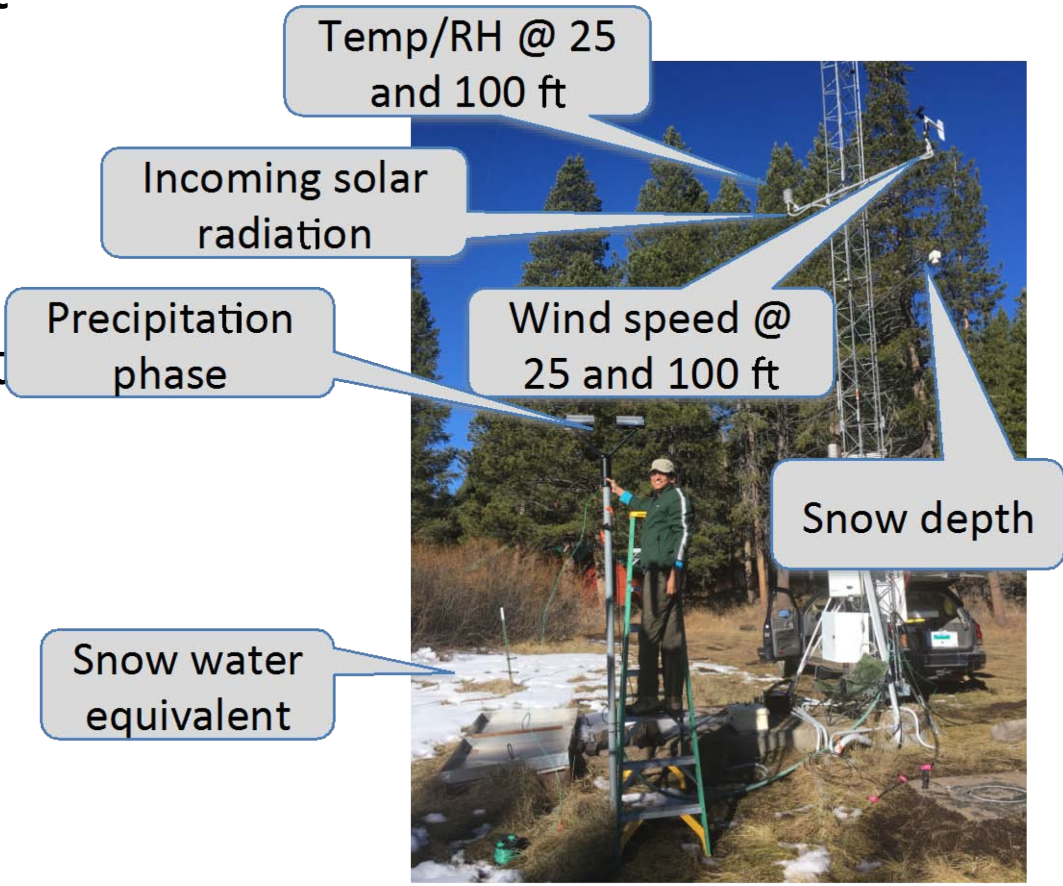
- A forested, experimental watershed spanning the rain to snow transition

Long-term measurement

- Streamflow: 1953-present
- Water quality: 1968-present
  - Water isotopes: 2002-present
- COOP Meteorology: 1953-present
- SNOTEL (X3): 1981-present
- NADP Deposition: 2001-present

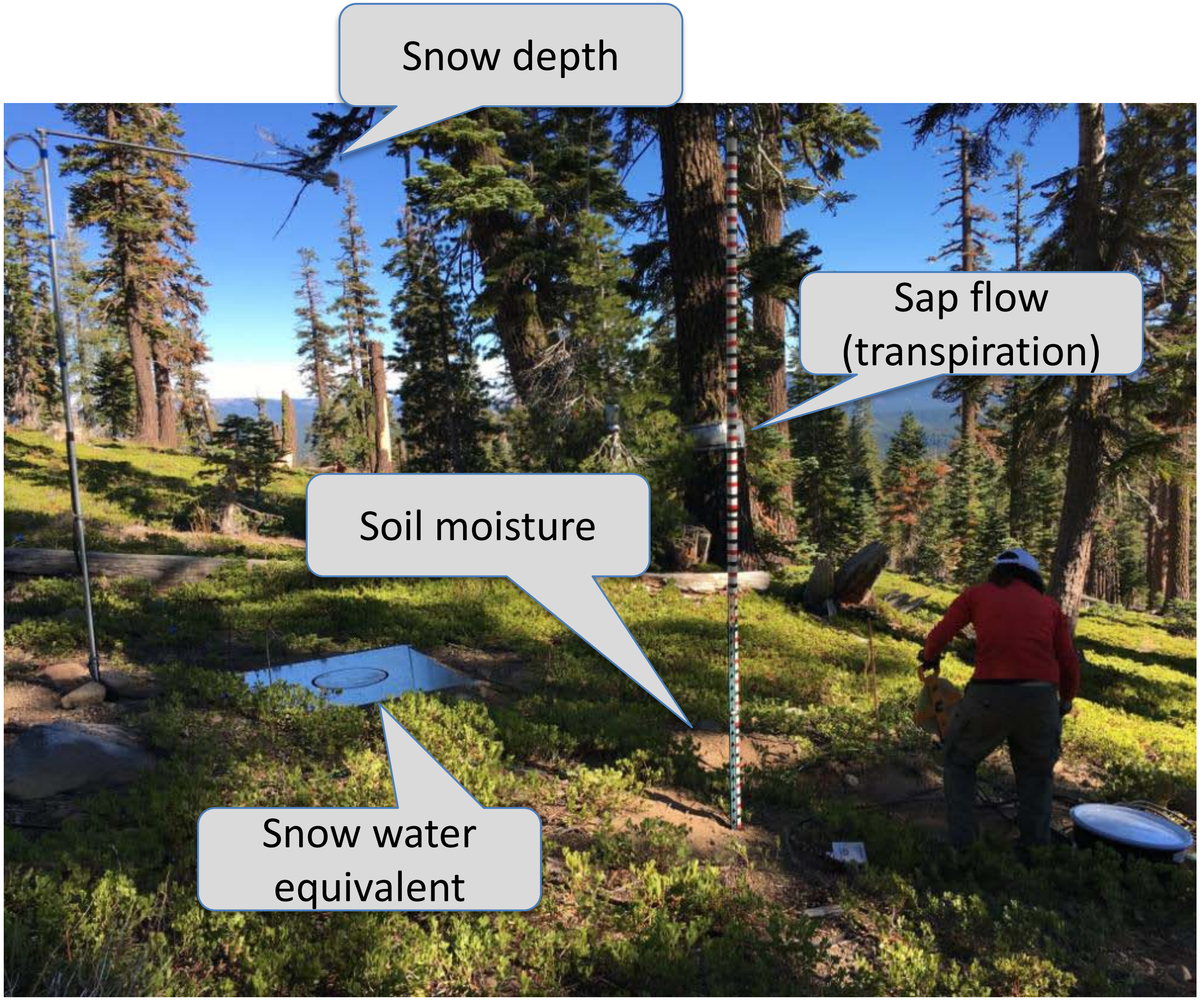
Infrastructure

- 30 ft. towers (X4): 2009-present
  - Temperature/RH @ 25 ft
  - Windspeed @ 25ft
- 100 ft. towers (X3): 2009-present
  - Temperature/RH @ 25 ft
  - Windspeed @ 25ft
  - Radiation
  - Precipitation (issue w/ long-term record)
  - Snow pillows (issue w/ long-term record)



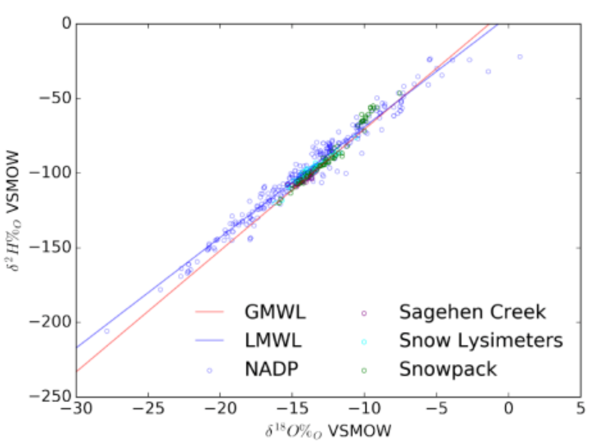
Ecohydrological clusters

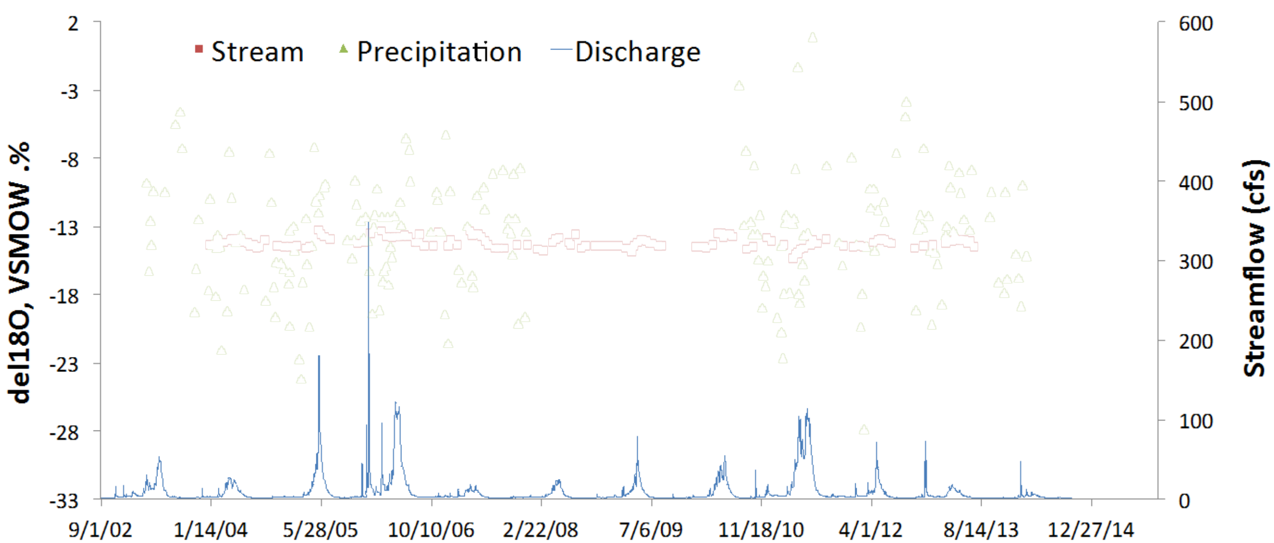
- Ecohydrological clusters
  - Soil moisture
  - Sap flux
  - Water isotopes



Novel observations: snow water isotopes

- Water isotopes are routinely used to track sources and age of water
- We modify wick lysimeters designs to temporally collect samples
- Lysimeters installed across a large elevation gradient

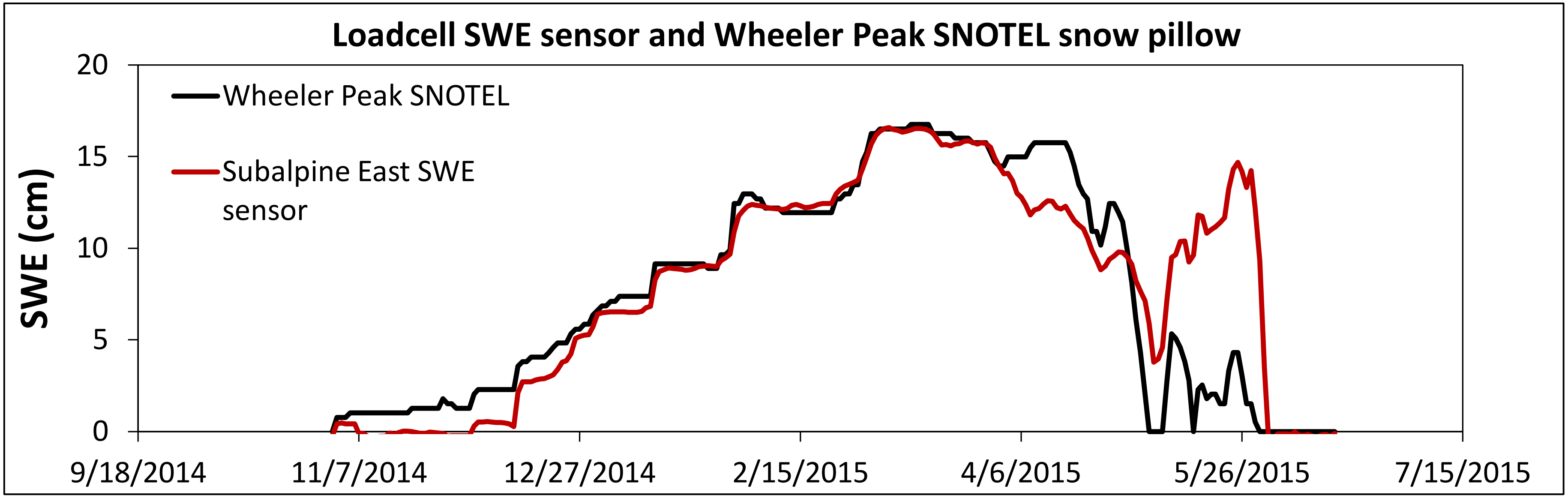




Novel observations: SWE plates

- New SWE sensor is capable of measuring snow under diverse canopy

Novel observations: SWE sensors versus snow pillows

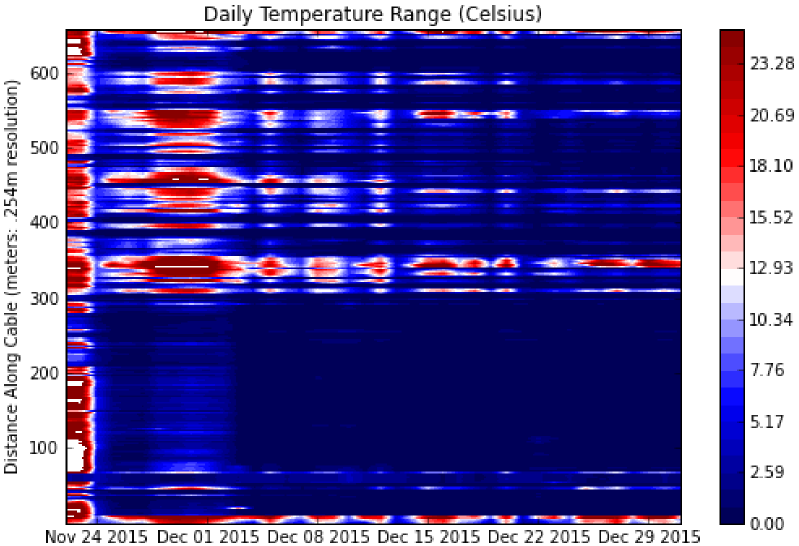


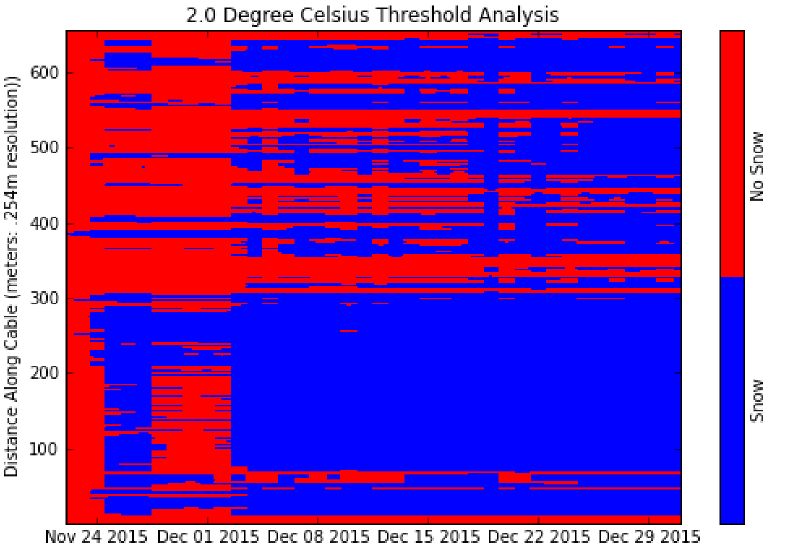
- Sensor is currently being tested at five locations in Sagehen Creek

Figure courtesy of Ben Trustman

Novel observations: distributed temperature sensing of snow cover

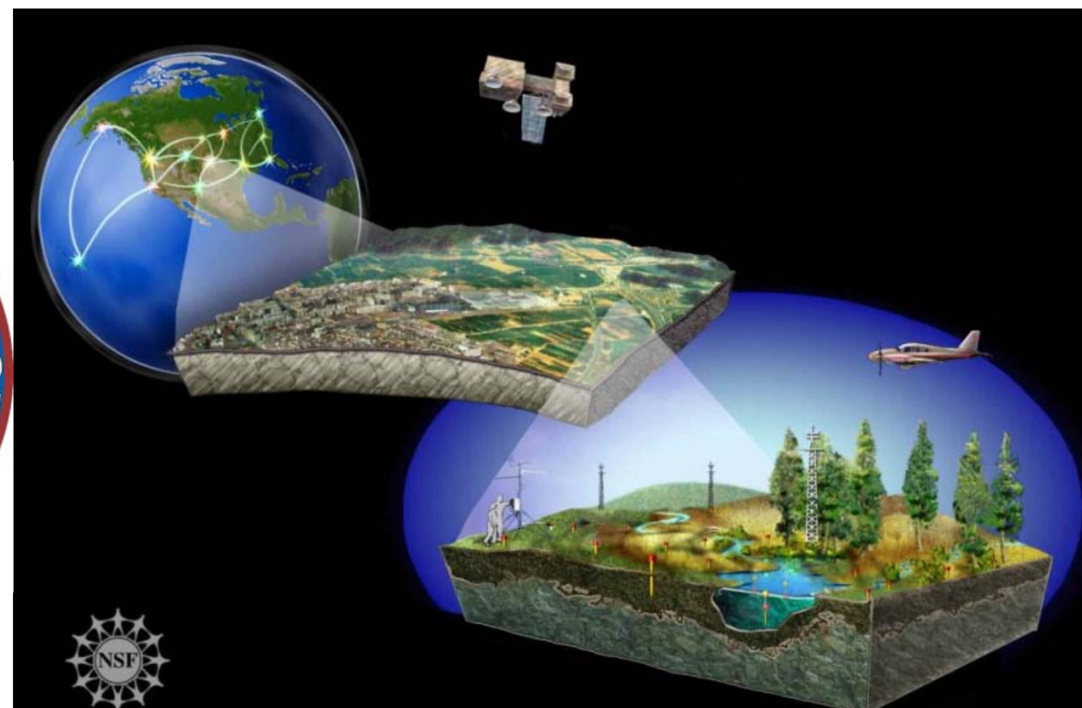
- Apply temperature sensing to measure snow presence/absence under trees
- 2000 m cable installed in Sagehen





Remote sensing for snow water management

- Multi-platform
  - Ground>Tower>Airplane>Satellite
- Multi-Sensor
  - Hyperspectral and LiDAR



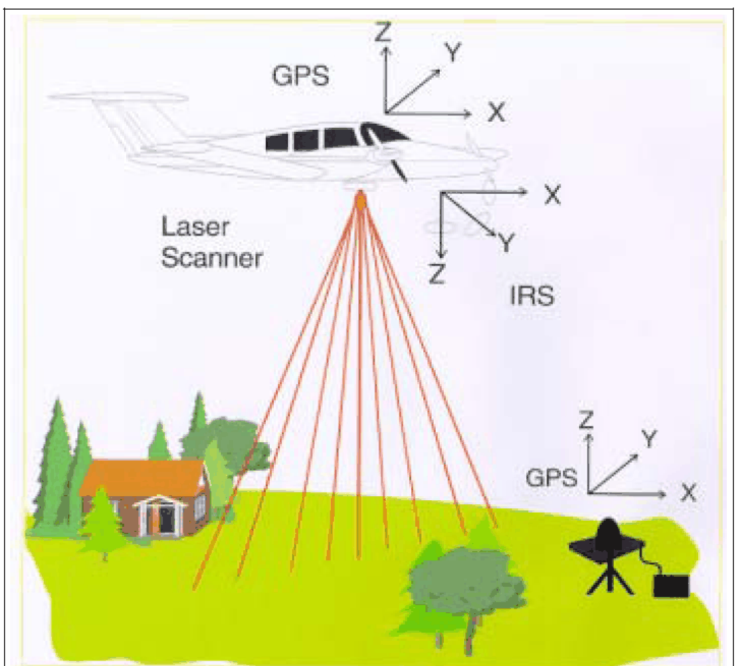
Modified from the image of Nicolle Rager Fuller, National Science Foundation, 2007

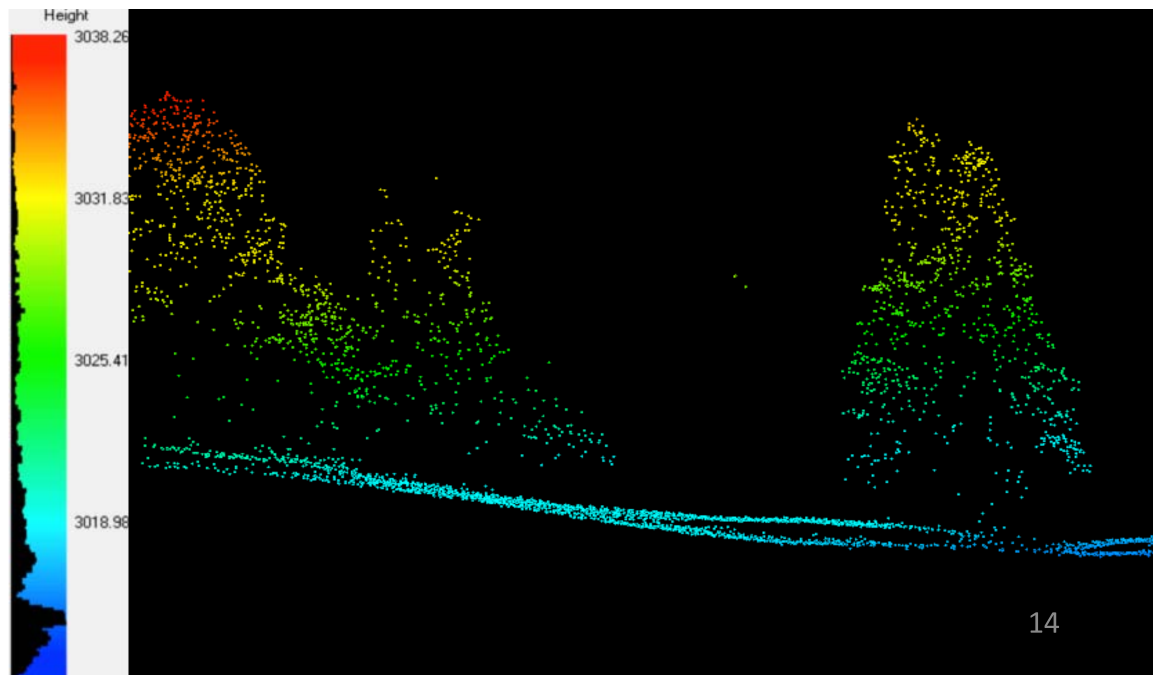
Hyperspectral remote sensing

- NASA AVIRIS: Hyperspectral 15 m resolution
  - February 2015
  - March 2016
  - April 2016 (expected)
  - May 2016 (expected)
- Coincident ground-based collection

Smart forest management using LiDAR

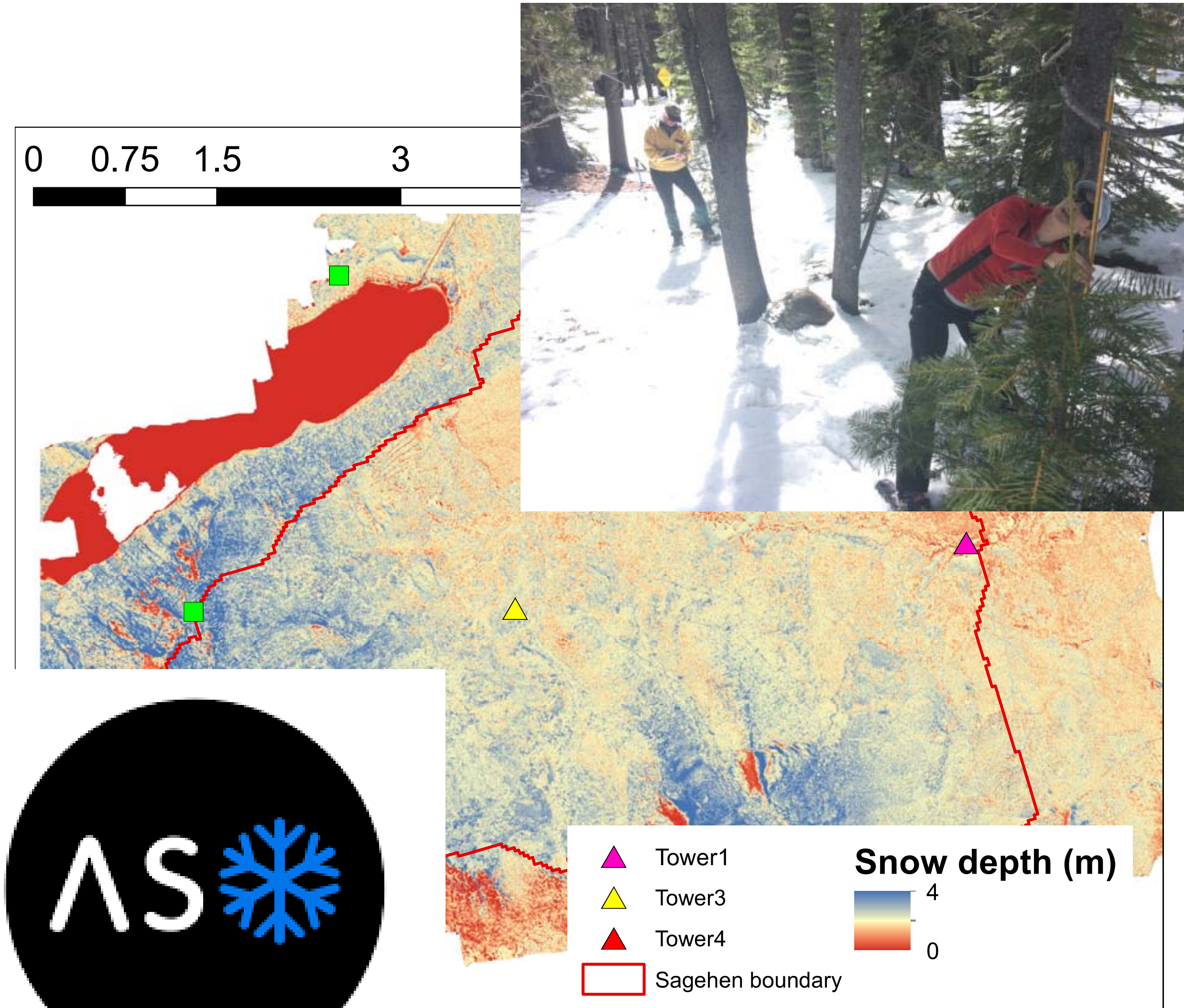
- Light Detection and Ranging (LiDAR)
- Physical structure of vegetation, snowpacks, and terrain
- High resolution over large extent
  - Sub-meter resolution
  - 100's of km^2 possible with airborne platforms



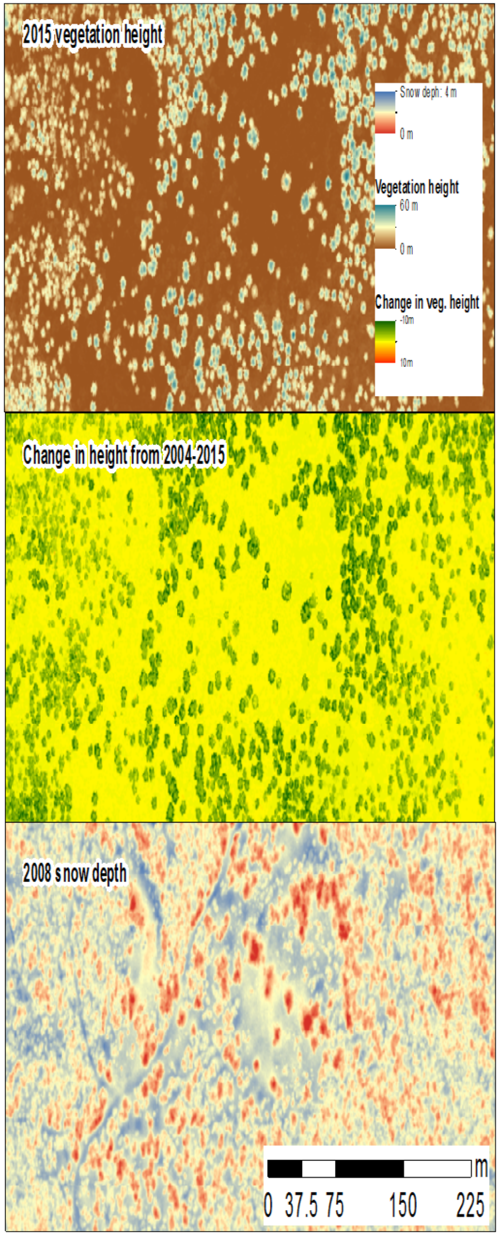


LiDAR in Sagehen Creek Watershed

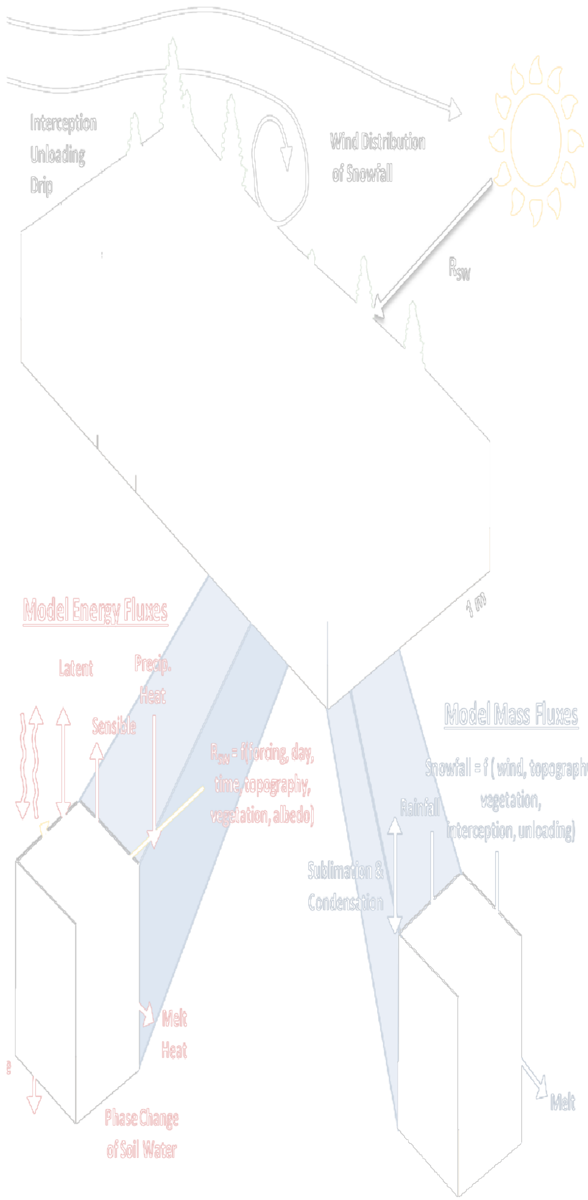
- A unique time series of LiDAR data
  - 2004 snow-off
  - 2007 snow-off
  - 2008 snow-on
  - 2014 snow-off
  - 2016 March snow-on (ASO)
  - 2016 April snow-on (ASO)
  - 2016 April snow-on (ASO)



Observations from Light Detecting and Ranging (LiDAR)



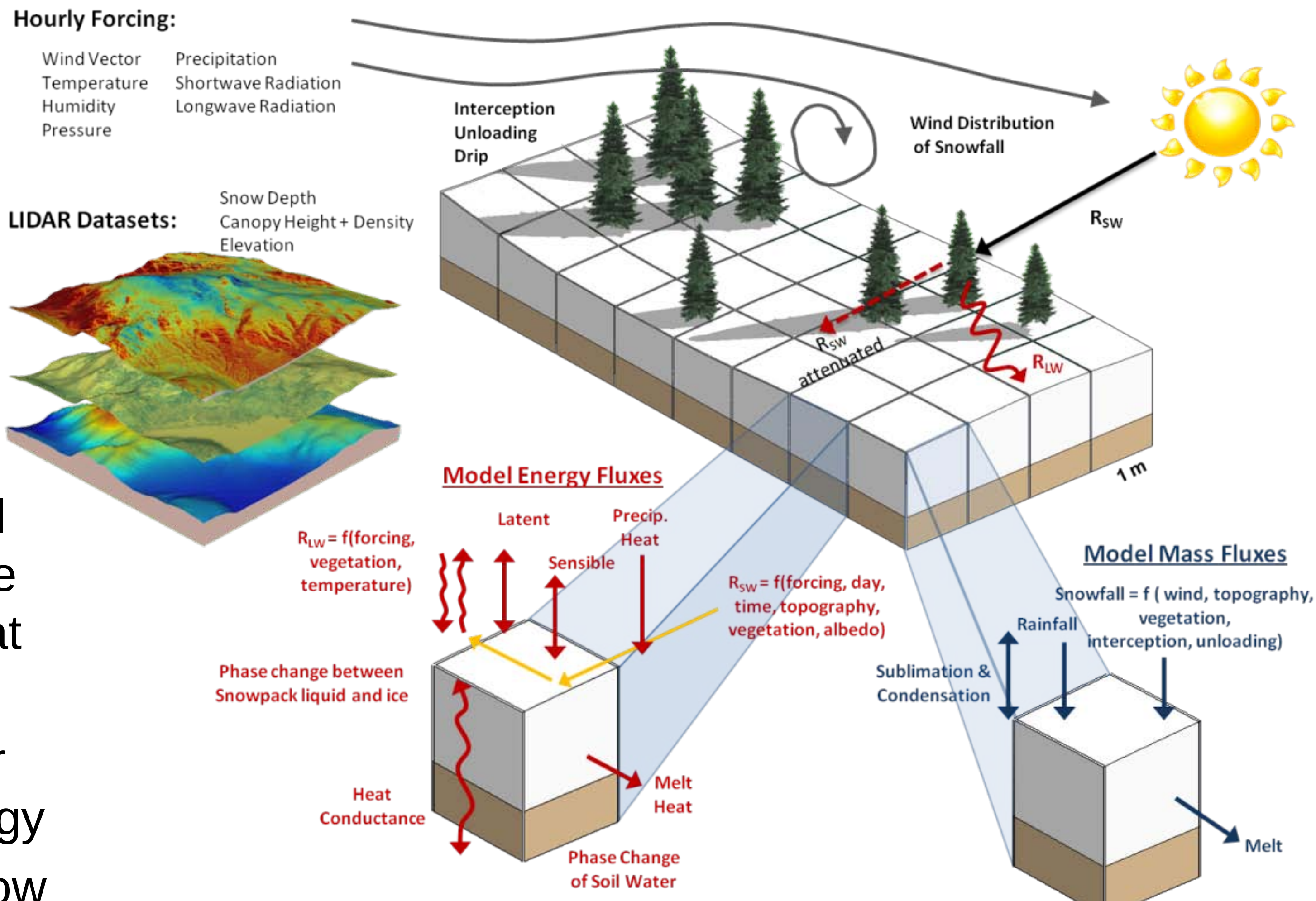
Snow Physics and Laser Mapping (SnowPALM) Model



Remote sensing for forest management

- Multi-platform
  - Ground>Tower>Airplane >Satellite
- Multi-Sensor
  - Hyperspectral and LiDAR
- Unique time series
  - 2004 and 2015 lidar for tree growth
  - Snow-on collects in 2016

Snow Physics and Laser Mapping (SnowPALM)

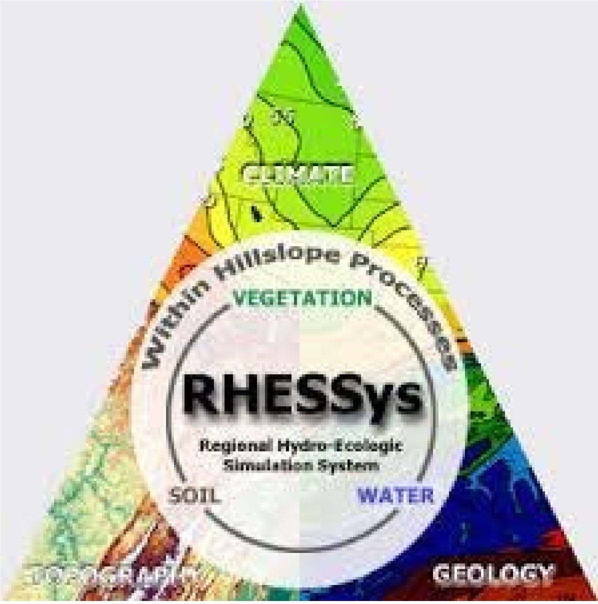


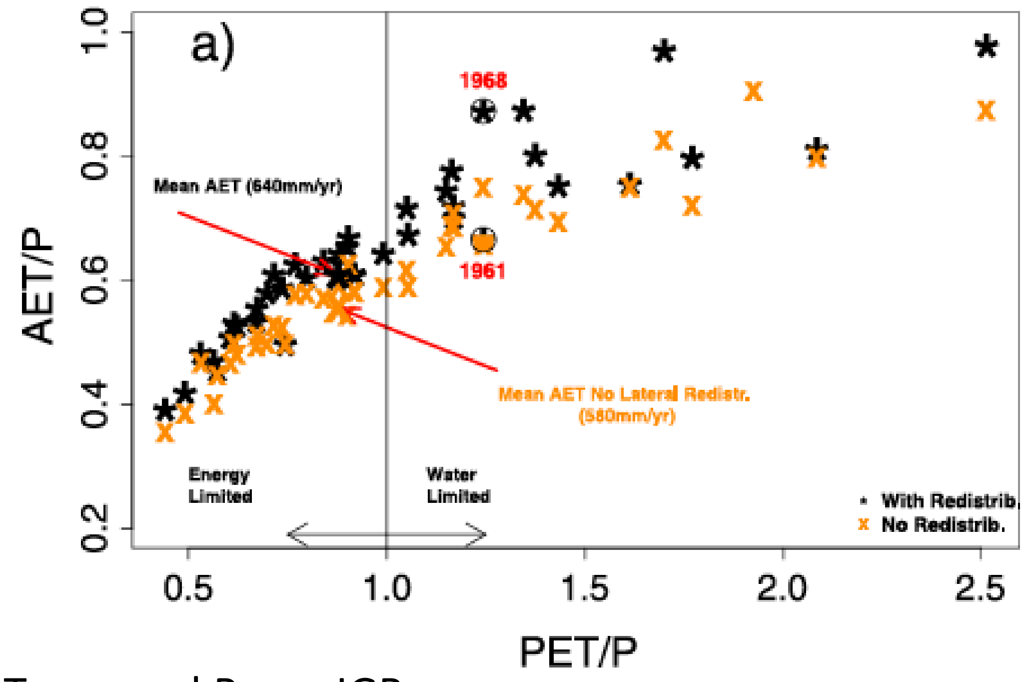
Broxton et al., Ecohydrology, 2015

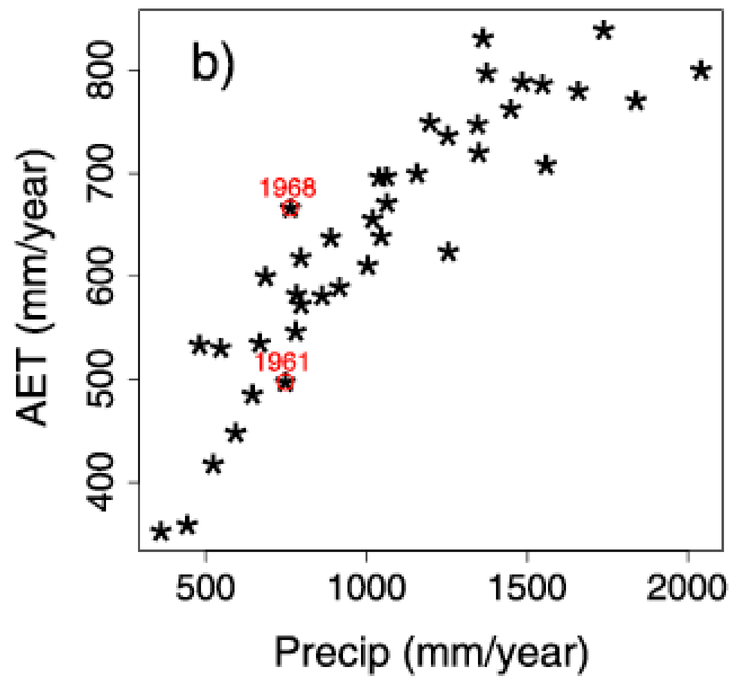
- Topography and canopy structure parameterized at 1-m resolution
- Forced by tower micrometeorology
- Verified with snow depth at 1-m scale

RHESSyS modeling

- RHESSyS model runs from 1960-2000







Tague and Peng, JGR

Questions