Integrated measurement and modeling of Sierra Nevada water budget

Specific aim: Develop integrated measurement and modeling strategies that combine remote sensing and ground-based data with state-of-the-art models to achieve accurate estimates of snowpack, snowmelt and the partitioning of snowmelt into runoff, infiltration and evapotranspiration. Four broad science questions motivate this research:

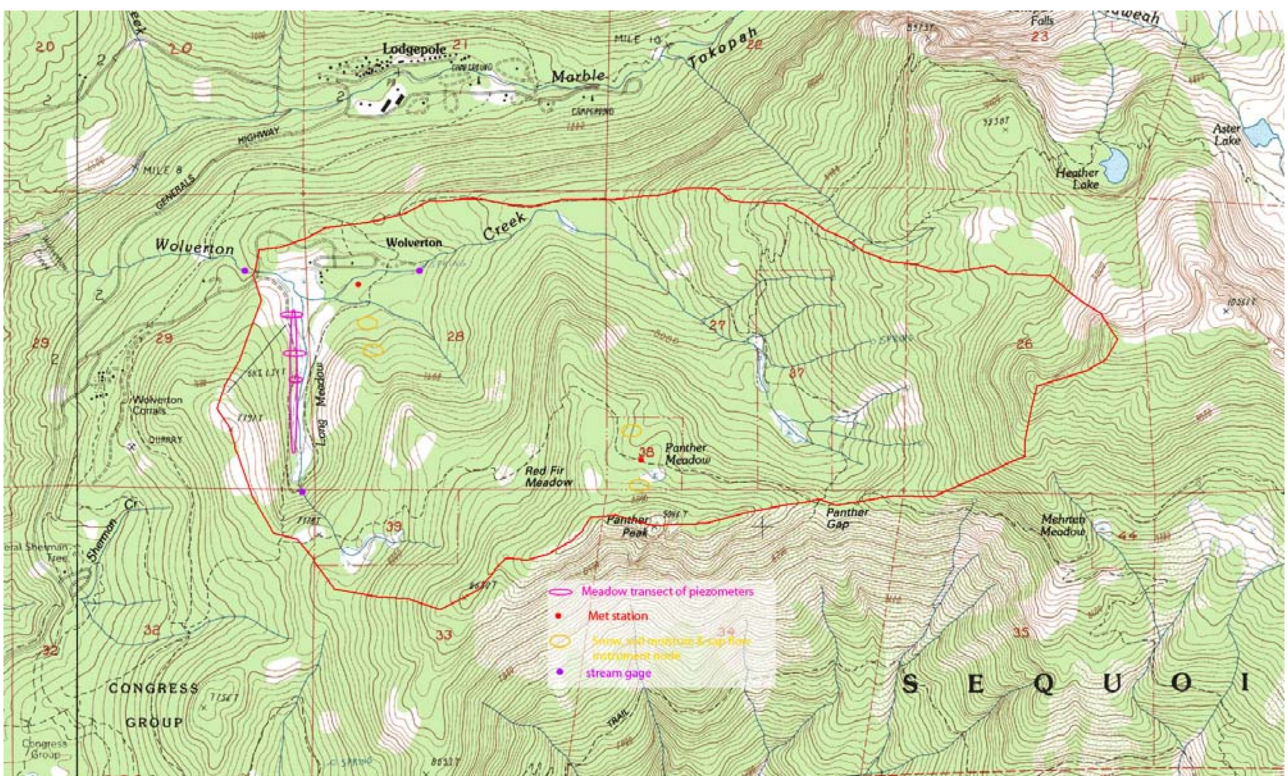
– How do hydrologic systems that are subjected to multiple perturbations respond?
– How do pulses and changes propagate through the hydrologic system?
– What are the time lags and delays of stresses in different systems?
– How can the predictive ability for these responses be improved?

Wolverton in summer, showing meadows in lower part of basin, and forested slopes above.

Location: Wolverton (36.5956ºN, 118.7333ºW) is a non-wilderness area at about 2170 m elevation, located in the Marble Fork of the Kaweah River basin, in Sequoia-Kings Canyon National Park. It is road accessible year round and in an area with complimentary long-term research measurements and investigations. The largely forested (mixed conifer), 8 km^2 Wolverton basin is nested within the 135 km^2 Marble Fork.

Primary objectives:

− Develop accurate, basin-scale measurement strategies for water balance in mountain basins.
− Integrate ground-based instruments with remotely sensed data and advanced hydrologic modeling to develop a process-level understanding of water cycle responses to perturbations in a representative mountain basin.



Layout of instrument clusters in Wolverton basin, showing meadow transects, and forest instrument nodes at multiple elevations and aspects.

Basic premise: Strategically placed instrument clusters, designed to complement satellite remote sensing information, together with models of surface and subsurface hydrology, provide the basis for more accurately and efficiently measuring and scaling the water balance, and thence basin-scale fluxes, than does an approach that relies on sparsely distributed measurements of the type now available.

Working hypotheses:
- Soil moisture patterns will follow the patterns for snowcover accumulation and depletion.
- Soil moisture measurements will also help to discriminate snow versus rain.
- Spatial variations in tree canopy cover are as important as slope and aspect for variability in snowcover and soil moisture.
- Measurable groundwater recharge occurs in meadows.
- Evapotranspiration is a dominant component of the water balance, greater than deep infiltration/runoff. It is greatest following spring snowmelt and is lowest in late summer and fall after the soil dries.
- Evapotranspiration continues through the winter at a significant rate, and increases in response to temperature during the snow-covered season and in response to soil moisture (precipitation) during the snow-free season.
- Accurate estimates of changes in spatial SWE across a basin can be developed using subpixel satellite snow covered area (SCA) and albedo plus canopy information and distributed energy balance modeling, with only limited ground-based SWE measurements.

Upper part of Wolverton basin during spring snowmelt

Wolverton meadow and basin in spring during snowmelt

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Project funding: LLNL, NSF and UC Merced
For more information and data: https://snri.ucmerced.edu/snho

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- Noah Molotch, UC Los Angeles, snow hydrology and measurement design
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Project status: Instrument cluster installation carried out in 2006, including stream stage and temperature, 2 meteorological stations, 4 soil-moisture, temperature and snow instrument nodes, meadow piezometers, wells and soil moisture. Installation of sap flow and data telemetry, plus further characterization and modeling to begin in spring 2007.