An Optimized Soil moisture Sampling design to Represent the Impact of Climate variability on Soil moisture and Vegetation water use in Snow-Dominated Watersheds

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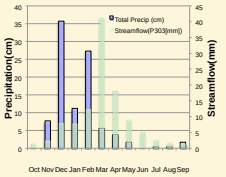
Abstract

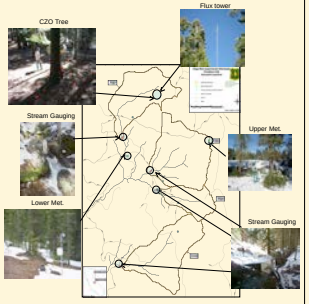
We develop a soil moisture (and vegetation water flux) sampling strategy that is explicitly designed to capture spatial heterogeneity that will likely be important in characterizing system responses to inter-annual climate variability. Our research site, the Sierra Critical Zone Observatory (CZO) is located in rain-snow transition zone, and thus offers an ideal site for investigating how inter-annual climate variability will change the spatial distribution of snow melt and associated soil wetting-drying and plant water use. Sampling design is selected using physically-based, spatially distributed eco-hydrologic model and associated statistical analysis. We initially calibrate the model to reproduce existing soil moisture, sap-flow and streamflow data. We use the model to generate spatial-temporal patterns of snow, soil moisture and transpiration under historical and projected future climate. These patterns are then clustered to identify areas of hydrologic similarity, where similarity will be defined by inter-annual mean and variation of a suite of hydrologic indicators (e.g. seasonal trajectories of snowmelt, root-zone soil moisture storage, and evapotranspiration). Results from this study will demonstrate the utility of such a closely integrated measurement-modeling approach.

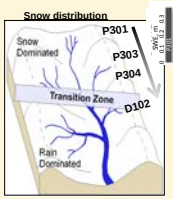
Southern CZO Watersheds

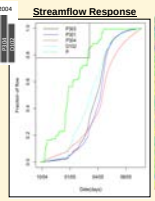
Site description

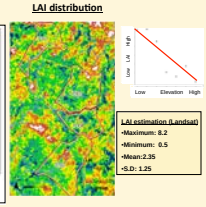
- Location: King River Experiment Watershed.
- Watershed sizes: 49 to 228 ha.
- Precipitation: 1350 mm(2002 to 2006).
- Soil: Shaver soil and Gerle-Cagwin soil
- Vegetation: Sierra mixed Conifer(>80%) with Ponderosa Pine, Montane Chaparral and mixed Chaparral..
- Elevation: 1485m to 2115m



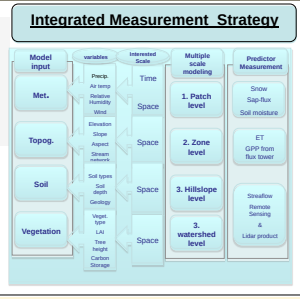








Integrated Measurement Strategy

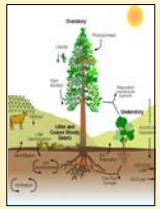


Research Questions

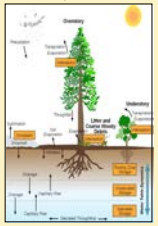
- **What are optimal additional soil moisture monitoring locations, given the goal of capturing within watershed spatial patterns of inter-annual (climate driven) variation in soil moisture dynamics?**
- **What are optimal sap-flux monitoring locations, given the goal of capturing within watershed spatial patterns of inter-annual (climate driven) variation in vegetation summer water stress?**

RHESSys Modeling framework

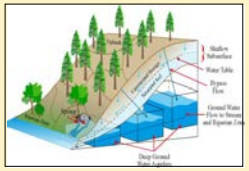
Carbon & Nitrogen Cycling



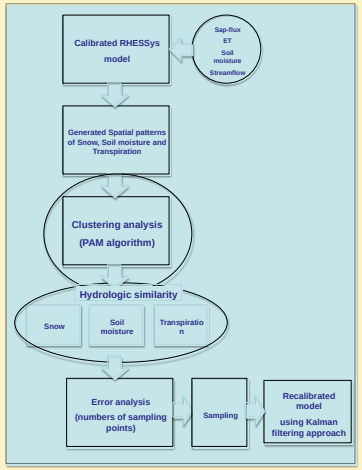
Vertical processes



Lateral Soil moisture redistribution



Using RHESSys to guide sampling design



Hydrologic Similarity Indicators

o mean and inter-annual variation (expressed as coefficient of variation, CV) of five indicators

1) Length of snow melt period,

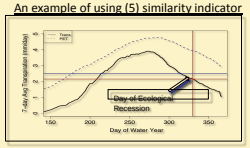
2) Days with fully saturated root-zone soil moisture

3) Days with greater than 70% saturated root-zone soil moisture

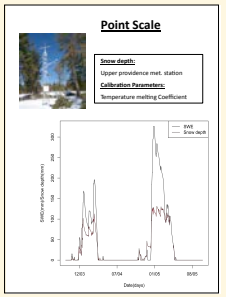
4) Day of year that root-zone soil moisture declines to midpoint between field capacity and wilting point

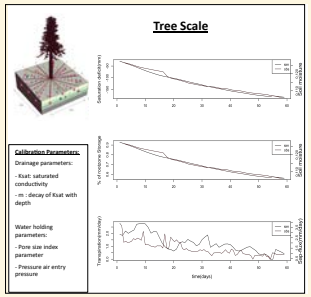
5) Day of year that transpiration declines to 50% of its peak growing season value

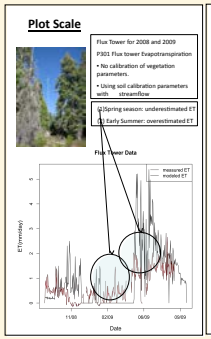
An example of using (5) similarity indicator

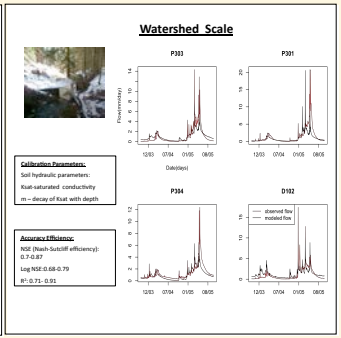


Model Performance

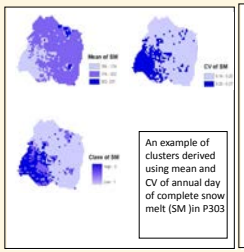




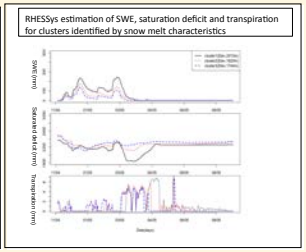




Clustering analysis results



An example of clusters derived using mean and CV of annual day of complete snow melt (SM)in P303



Summary

- **Using physical distributed model and statistic analysis to guide soil moisture and sapflux measurement**
- **Data collected at different scales was used to test the model performance**
- **Additional sampling data will be used to constrain the model parameter spaces and reduce the model uncertainty.**

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