Effect of soil parameter uncertainty on assessing climate change projection in two small Sierra Nevada watershed

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1.Research Background

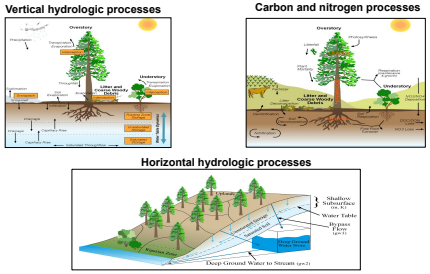
- The importance of soil parameter uncertainty in hydrologic modeling is generally well understood, but its effect is not well studied in climate change impact analysis, especially for Sierra Nevada watersheds in California.
- The sensitivity of model estimates to soil parameter uncertainty varies with study sites and the variable of interest.
- Estimates of the impact of climate change on hydrology are needed for lower order catchments that are the focus of forest management practices and stream restoration projects.

2. Research objective

1) Quantify and compare model accuracy and sensitivity of ecohydrologic estimates (streamflow, evapotranspiration and net primary productivity) to soil parameter uncertainty for a snow-rain transition watershed (TSW), and a snow-dominated watershed (SDW) in the California Sierra.

2) Compare the variation of ecohydrologic responses to soil parameter uncertainty with the variation of these ecohydrologic responses to climate warming

3.RHESSys Modelling Framework



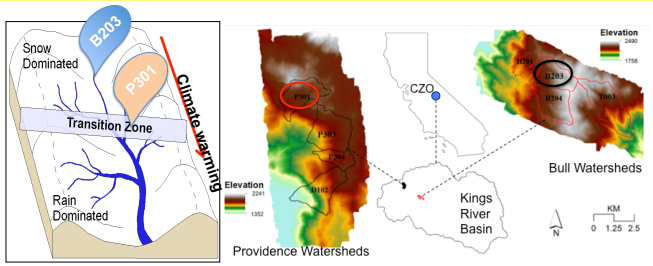
4. The uncertainty analysis

Generalized Likelihood Uncertainty Estimation (GLUE):
- All soil parameters values sampled using uniform distribution (based on literature values)
- Behavior soil parameter sets are selected based on streamflow accuracy.

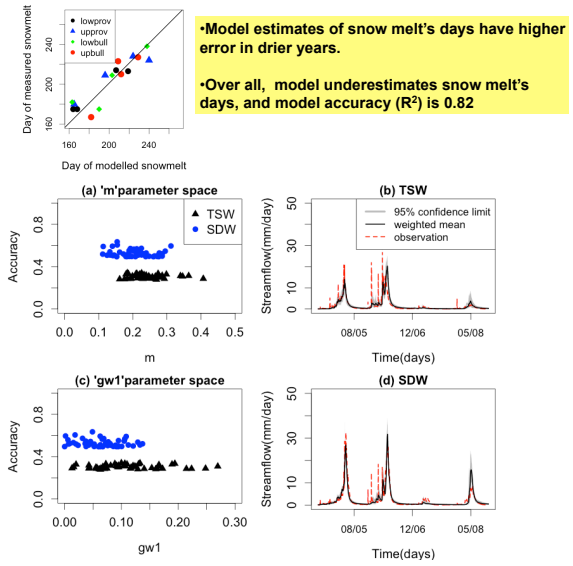
Calibrated six soil parameters:
- Anisotropic saturated hydraulic conductivity (*Ksat*),
- Decay of saturated hydraulic conductivity with depth (*m*)
- Fraction of infiltrated soil water that directly drains to deep groundwater stores (*gw1*)
- Air entry pressure (*ae*)
- Pore size index (*psi*)

5. Study sites

- Location: P301(1.32km2) and B203 (1.4km2) in King River Experiment Watersheds and part of Southern Sierra Critical Zone Observatory
- Precipitation: 1513mm(P301), 1517mm(B203), On average, 20 to 50% of the annual precipitation at P301 falls as snow. In B203, 75 to 95% falls as snow.
- Soil: Both soil types are highly permeable and have high percentages of sand.
- Vegetation: Sierra mixed Conifer(>80%) with barren land and mixed Chaparral, and P301 has denser tree cover (higher LAI) than B203.
- Elevation: P301(1794 to 2102m), B203(2182 to 2490m)



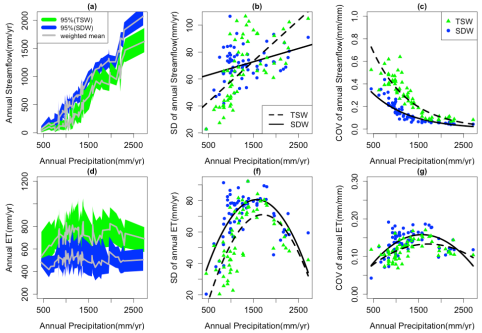
6. Snow calibration and the uncertainty of daily flow estimates



- Model estimates of snow melt's days have higher error in drier years.
- Over all, model underestimates snow melt's days, and model accuracy (R^2) is 0.82

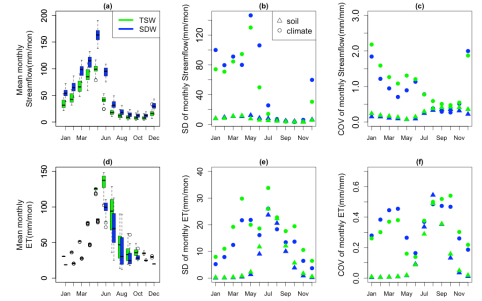
- TSW has wider behavior soil parameter ranges than SDW.
- TSW has lower streamflow accuracy and higher predictive uncertainty than SDW.
- Because TSW more often experiences limitations related to soil water capacity relative to SDW, the predictive uncertainty of model estimates due to soil parameter uncertainty was larger in TSW.

7. The uncertainty of annual model estimates



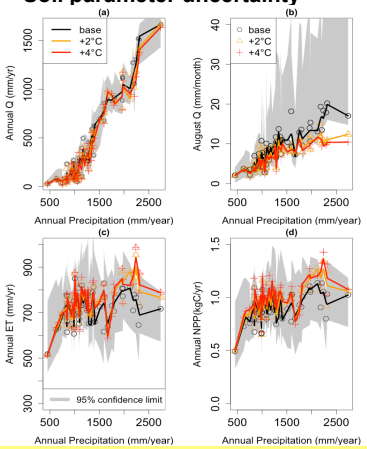
- The drier (less snow) watershed (TSW) also has higher sensitivity of annual streamflow to soil parameter uncertainty than the wetter (more snow) watershed (SDW).
- In drier years, the variation of annual ET due to soil parameter uncertainty is reduced because ET was limited by input (precipitation or snowmelt) rather than storage.
- In wetter years, ET is often limited by colder temperatures and shorter growing season length which reduced the sensitivity to soil parameters.

8. The uncertainty of monthly model estimates



- Variation (as SD and COV) are computed across both inter-annual climate variation (climate) and across soil parameter uncertainty (soil).
- The impact of inter-annual climate variability on monthly streamflow, ET and NPP is larger when water is not limited.
- With water limitation, the sensitivity of seasonal streamflow, ET and NPP to soil parameter uncertainty is comparable in magnitude to the variation associated with inter-annual climate variability.

9. Climate warming vs Soil parameter uncertainty



- For warming scenarios, we choose the best soil parameter set (having most accurate streamflow prediction) to simulate model estimates.
- In both TSW and SDW, soil parameter uncertainty had a larger influence on estimated annual ecohydrologic estimates than the two warming scenarios.
- However, the effect of warming on summer streamflow in the wetter years became larger than soil parameter uncertainty effect.