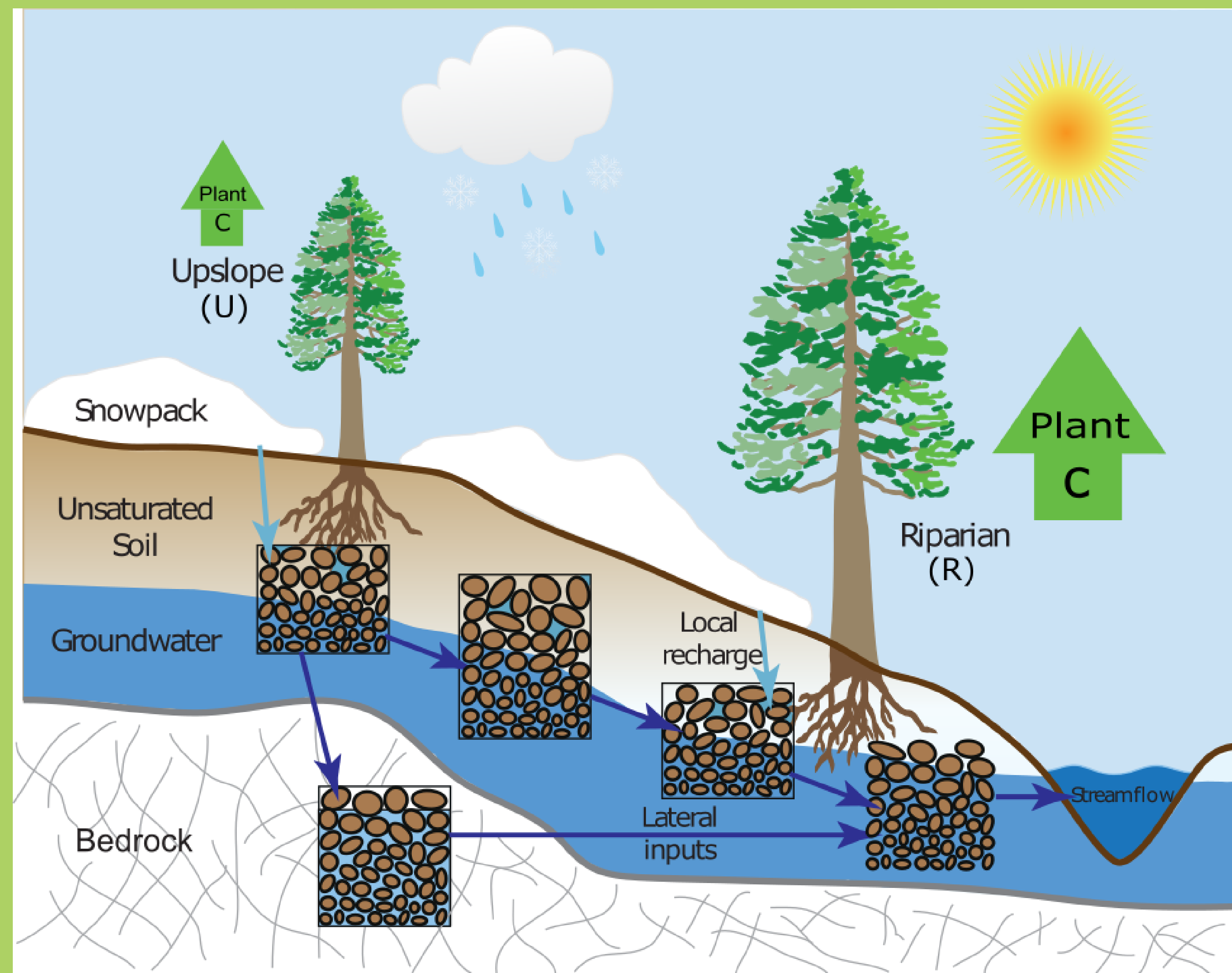# Will Riparian Refugia be Threatened by Snow Drought?

Louis Graup[1], Naomi Tague[1], Adrian Harpold[2], Sebastian Krogh-Navarro[3]
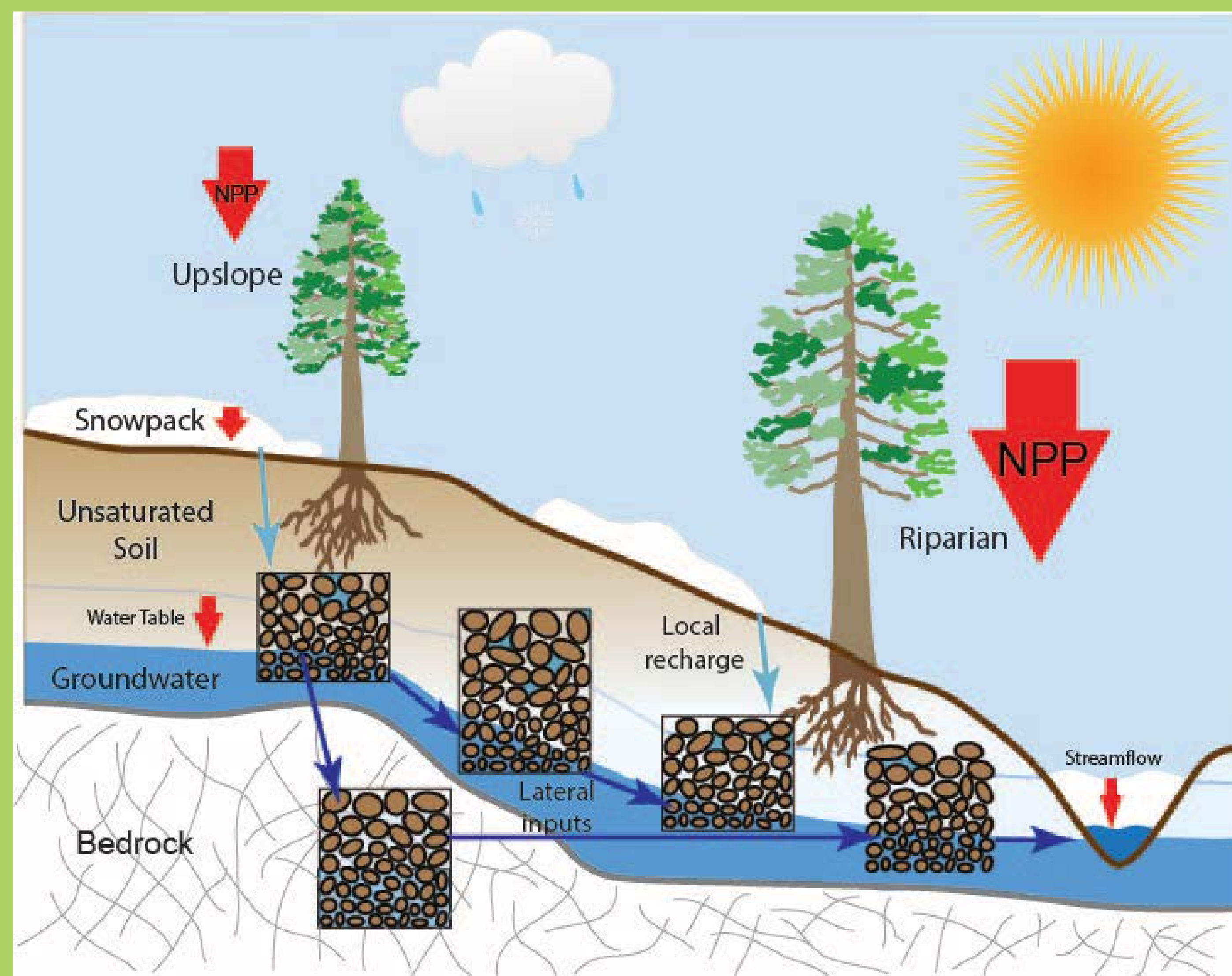
H25C-1077   University of California, Santa Barbara[1]; University of Nevada, Reno[2]; University of Concepción[3]

Conceptual Model

Long-term hillslope-scale forest structure
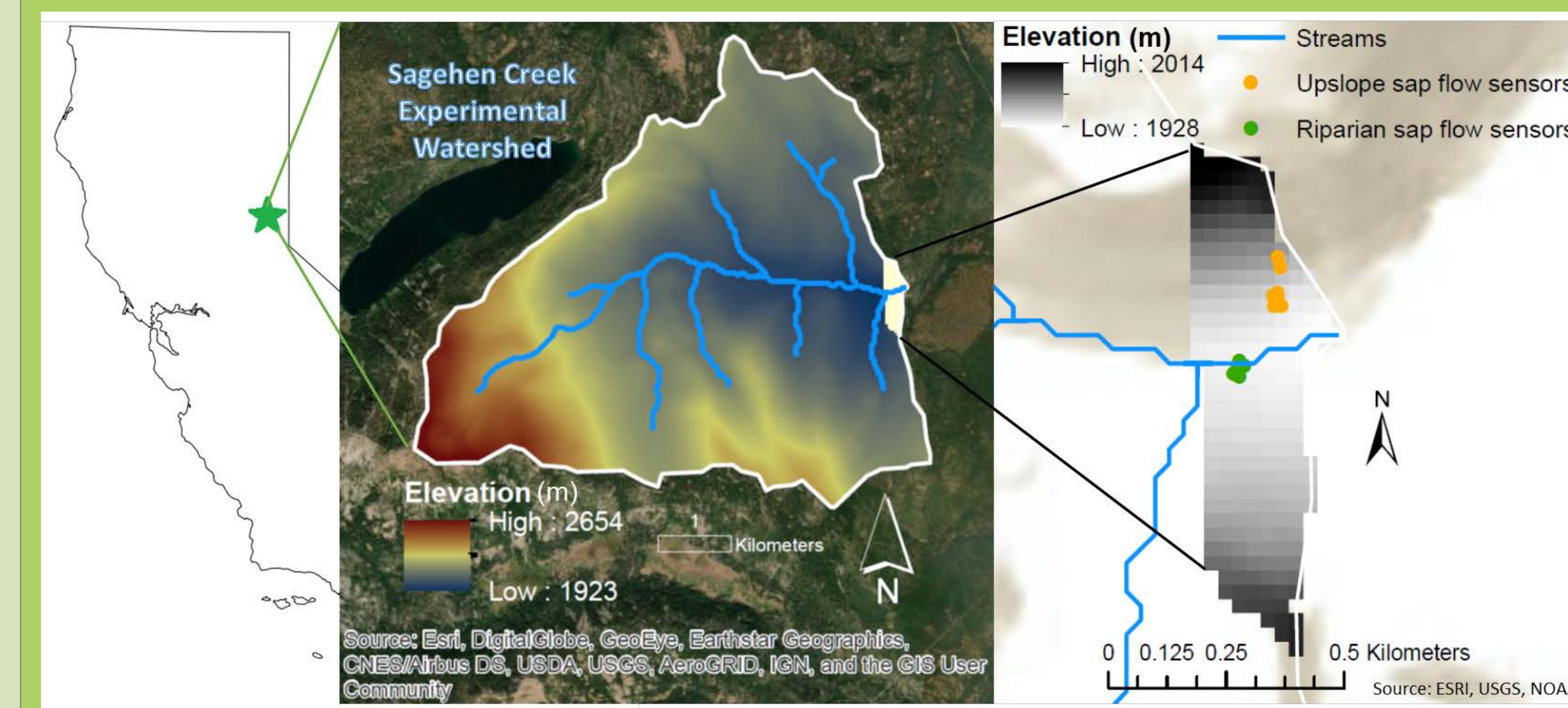

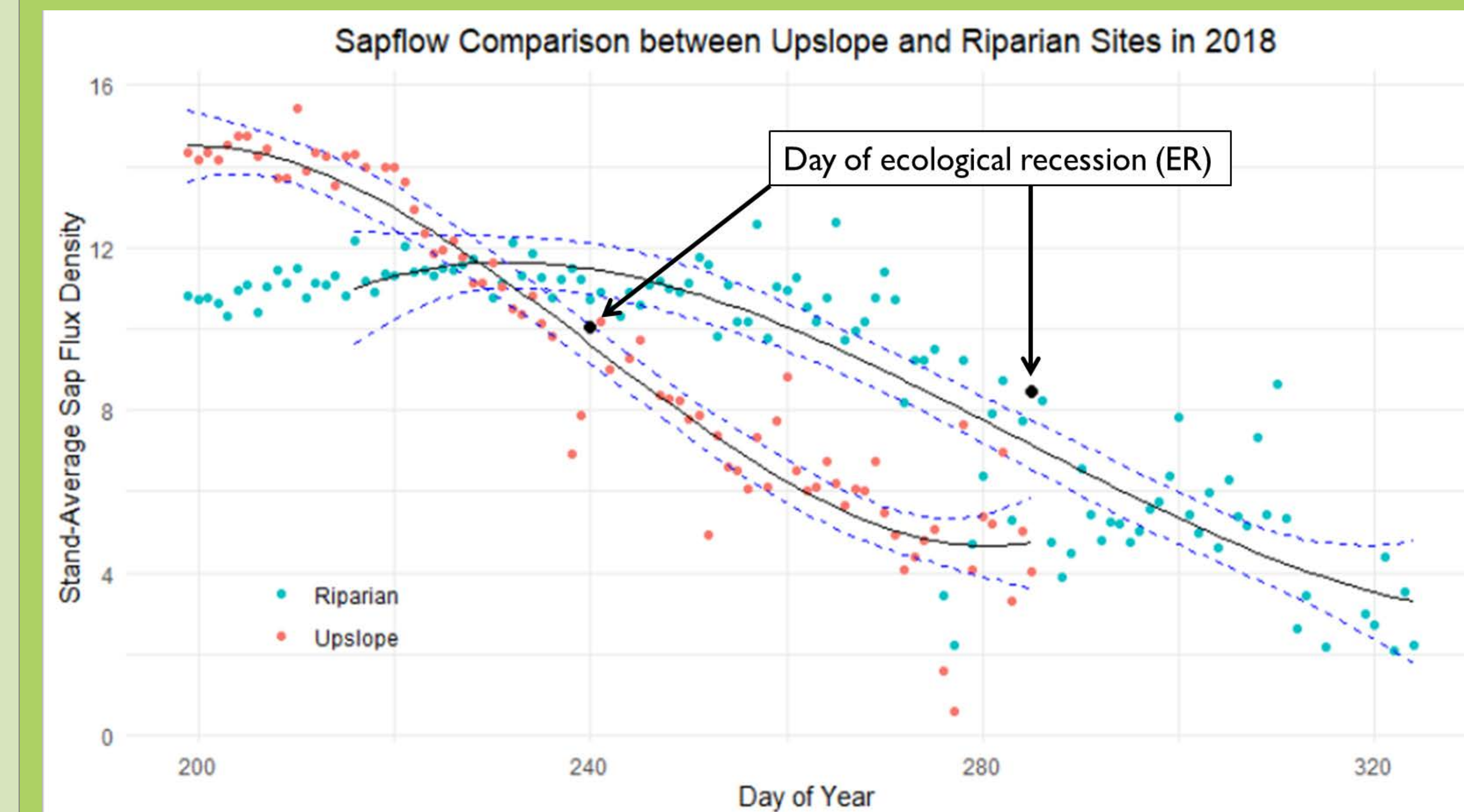### Hypothetical riparian drought response scenario

Research Questions

1) How does subsurface lateral redistribution influence seasonal water stress over multiple drought years?

2) How will these responses change for dry vs warm snow drought?

Study Site – *Sagehen Creek Experimental Watershed in Sierra Nevada, CA*

- Catchment area: 27 km²
- Hillslope area: 0.217 km²
- Elevation: 1,923m – 2,654m
- Mean Annual Precipitation: 850 mm
- Mean Winter Temperature: -9.5/3.7 °C
- Mean Spring Temperature: -2.5/13.8 °C
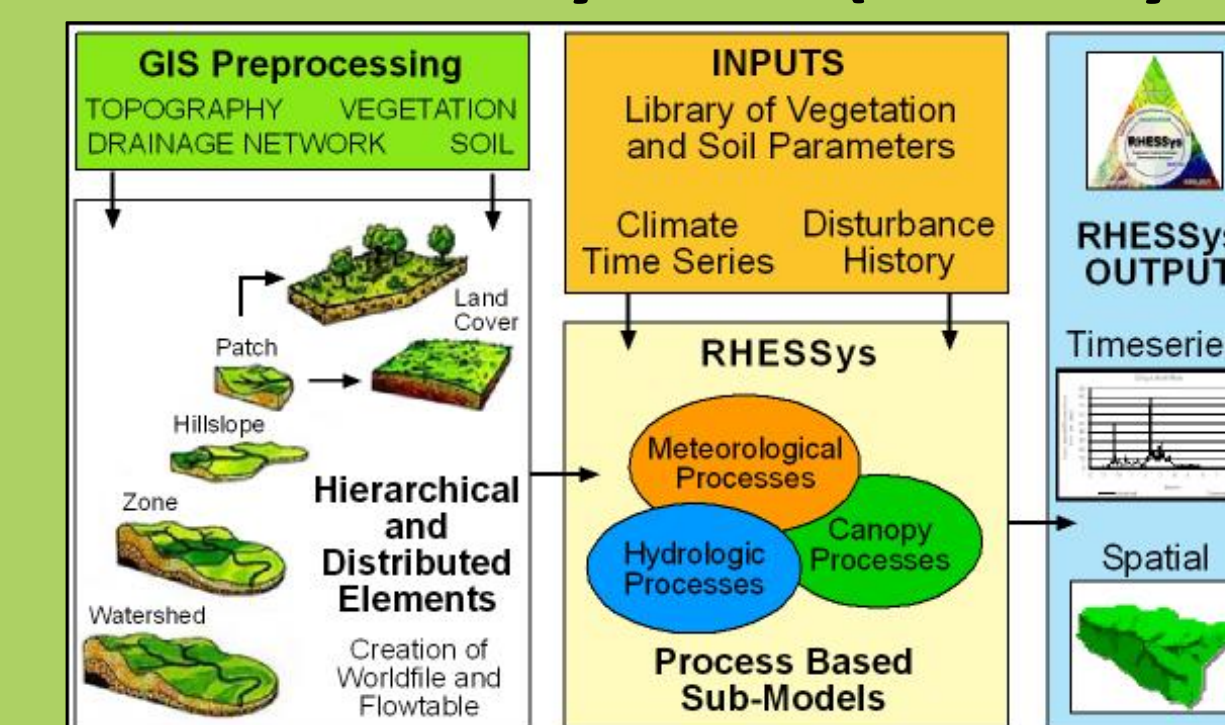

Sap Flow Analysis

Graphical depiction of calibration metric — the difference in day of ecological recession between upslope and riparian stands (ER_diff) was 45 days in 2018 — derived from peak daily sap flux data to calibrate subsurface drainage parameters in RHESSys

Model: Regional Hydro-Ecological Simulation System (RHESSys)

RHESSys simulates coupled carbon, water and nutrient cycling over spatially heterogeneous terrain, processes include:
a) Snow accumulation and melt
b) Subsurface lateral redistribution
c) Shallow and deep groundwater
d) Transpiration and photosynthesis

Model Comparison Against Observations

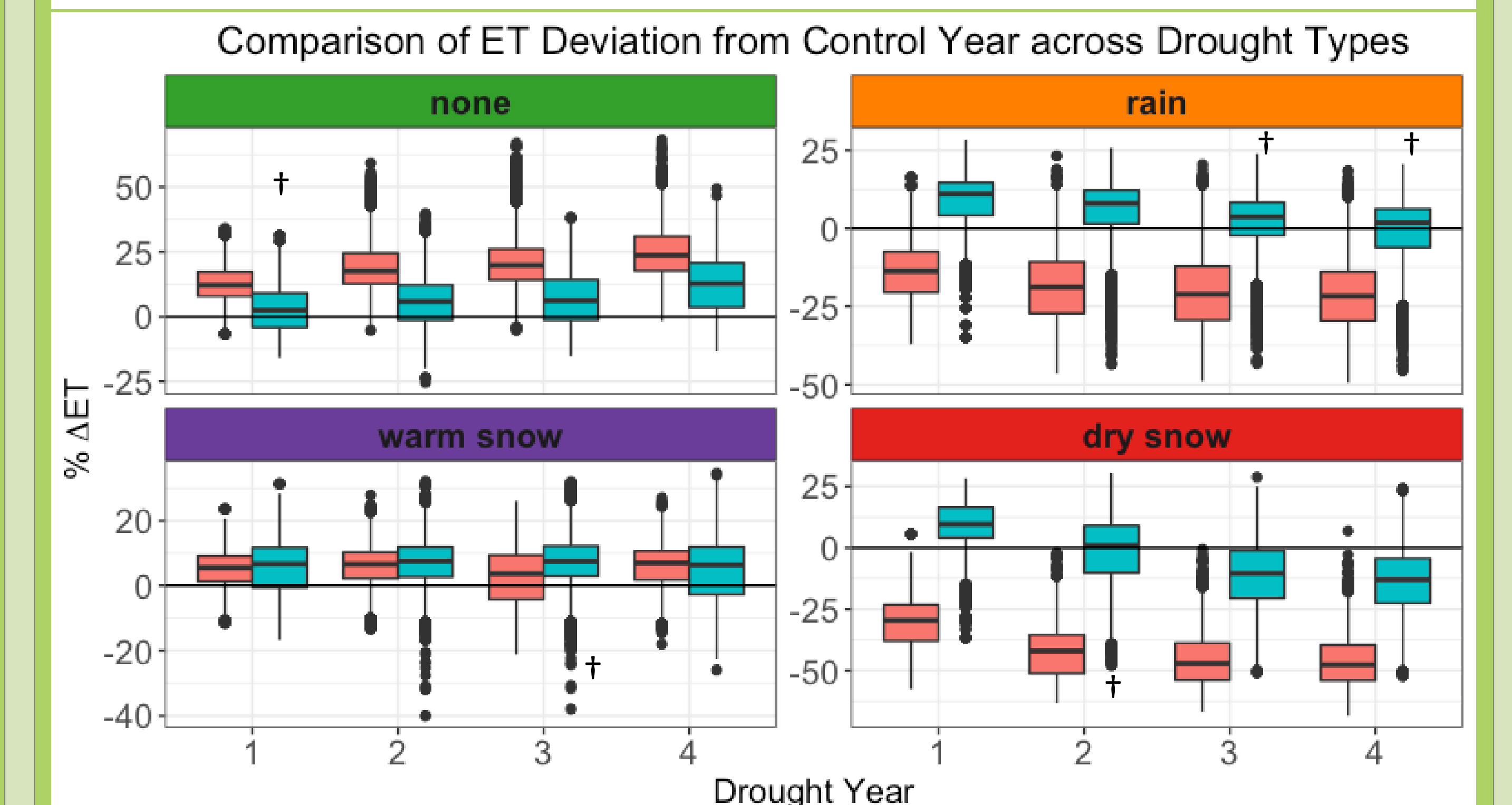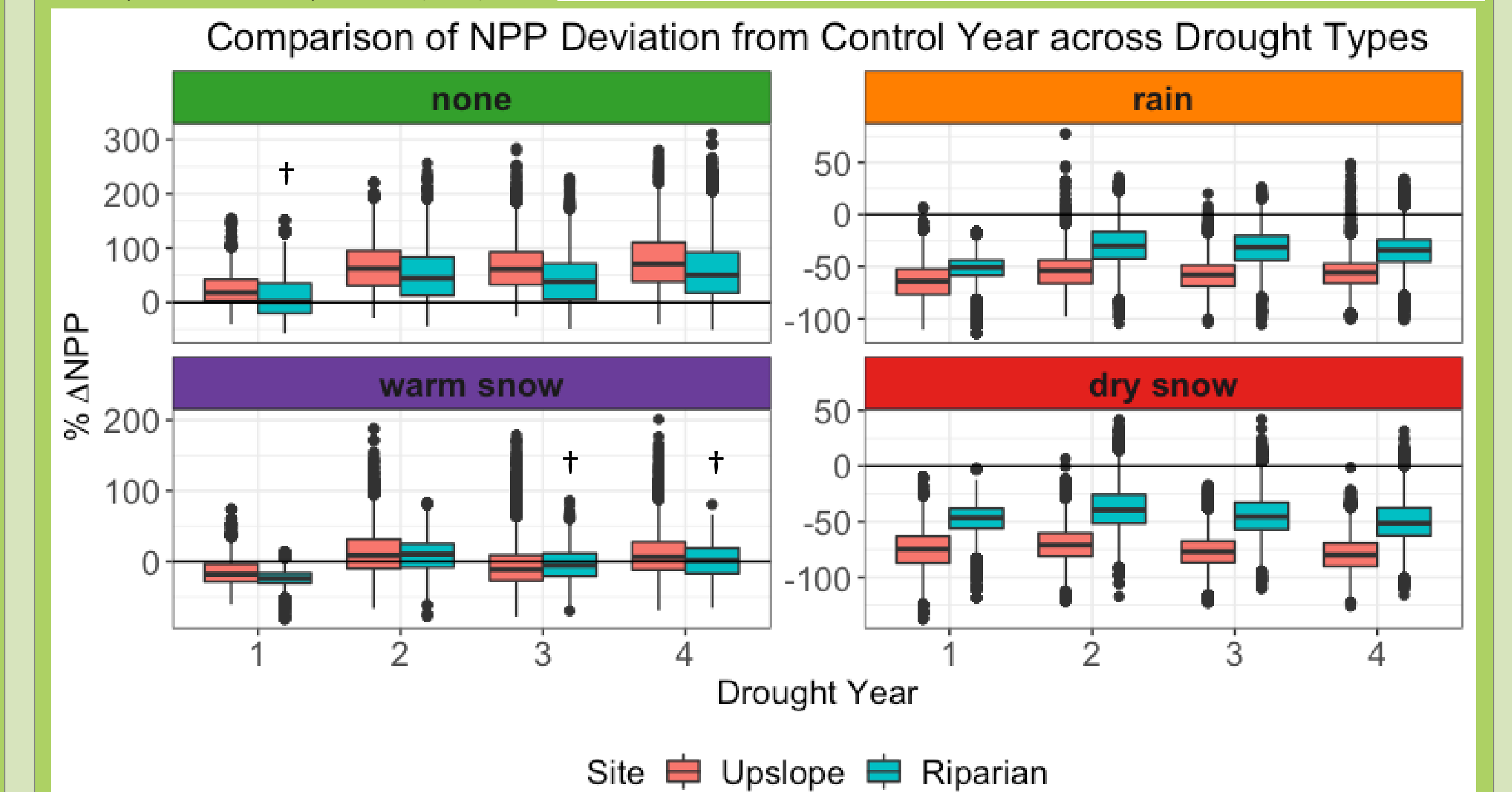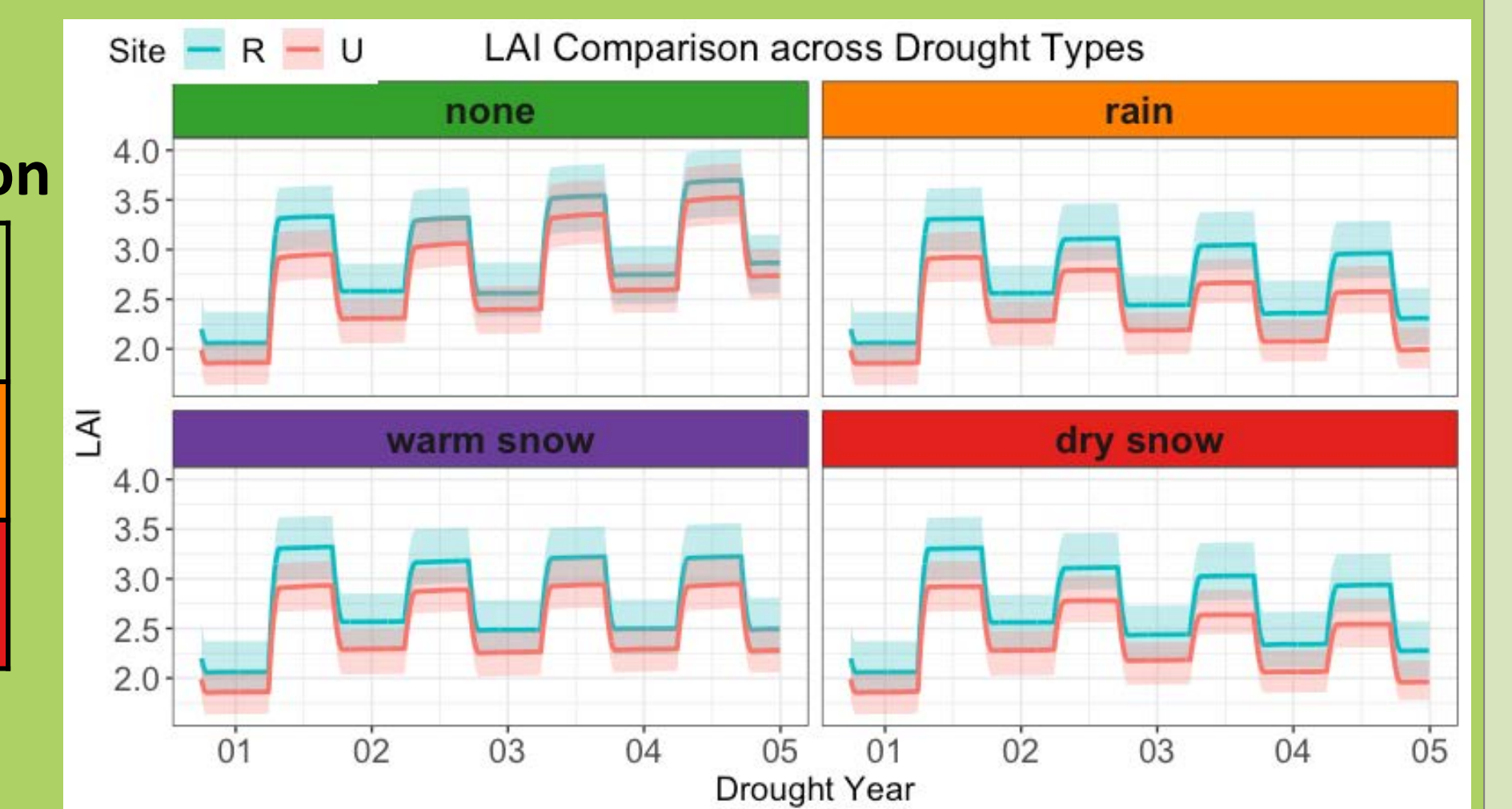| Growth Metric	Observed Range	Source	Model Estimates
Tree Height (m)	3 - 32	Xu *et al.* (2018)	17.7 (4.7)
ΔHeight (m)	0 - 5	Xu *et al.* (2018)	1.3 (0.4)
ER_diff (days)	45 ± 12	This study	35 - 60
Leaf Carbon (g C / m²)	60 - 363	Law *et al.* (2001)	244 (45)
Stem Carbon (g C / m²)	1,656 - 13,542	Law *et al.* (2001)	1,692 (351)

Model estimates presented as "mean (standard deviation)" (or "min-max" for ER_diff) over behavioral parameter uncertainty

Results

Drought Type Classification

	P		
SWE		> Mean (677 mm)	< Mean
> Mean (128 mm)		None	Rain
< Mean		Warm snow	Dry snow

P & SWE are hillslope-scale accumulated precipitation and snow water equivalent on April 1st il. From Harpold *et al.* (2017)

Boxplots of RHESSys estimates over parameter and climate uncertainty for upslope and riparian sites across drought types over time. † shows nonsignificant difference from control year, all other results are statistically significant at α=0.05

Conclusions

- Riparian trees in Mediterranean-type ecosystems are buffered against drought stress by subsurface lateral inputs
- Dry snow and rain droughts cause greater loss of biomass for both upslope and riparian trees compared to warm snow droughts
- Warm snow droughts in particular can increase riparian water stress, potentially threatening riparian hydrological microrefugia