

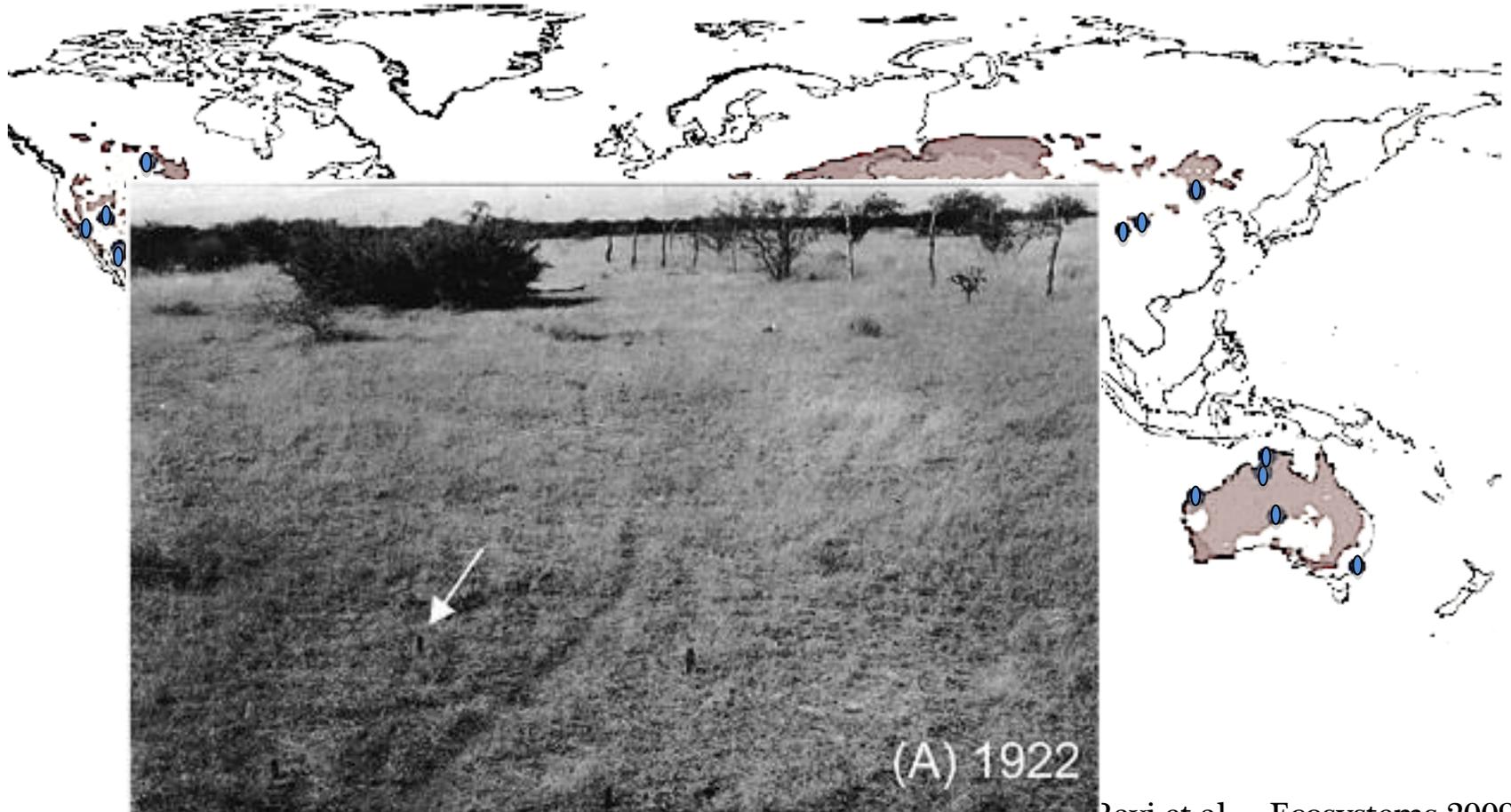
# The relative controls of temperature and soil moisture on soil CO<sub>2</sub> efflux under a changing landscape

Greg A. Barron-Gafford



Biosphere 2

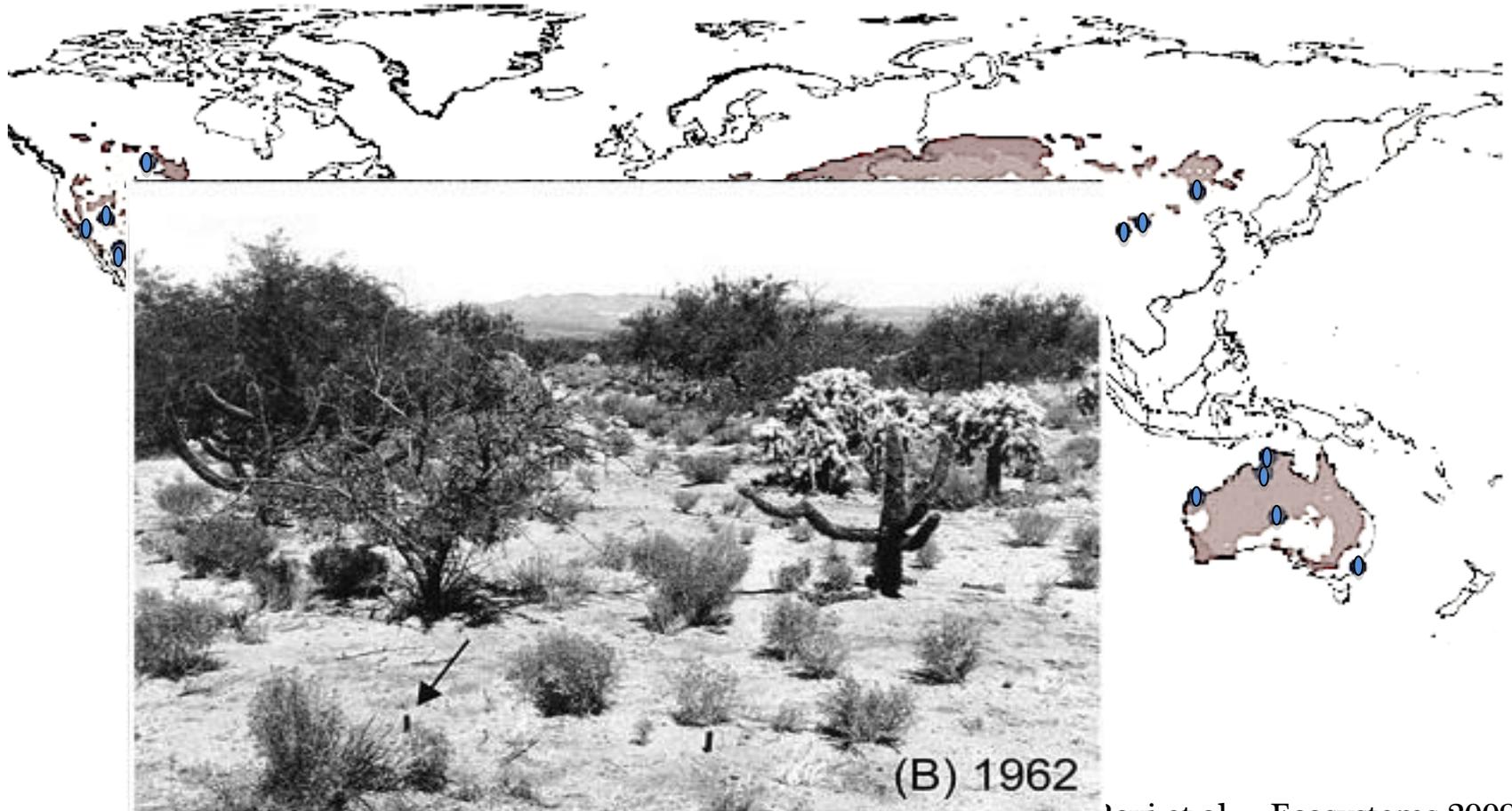
WPE is the transition in vegetative cover from an ecosystem dominated by grasses to one occupied by woody shrubs or trees



Browning et al. ~ Ecological Application 2008

modified from Ravi et al. ~ Ecosystems 2009

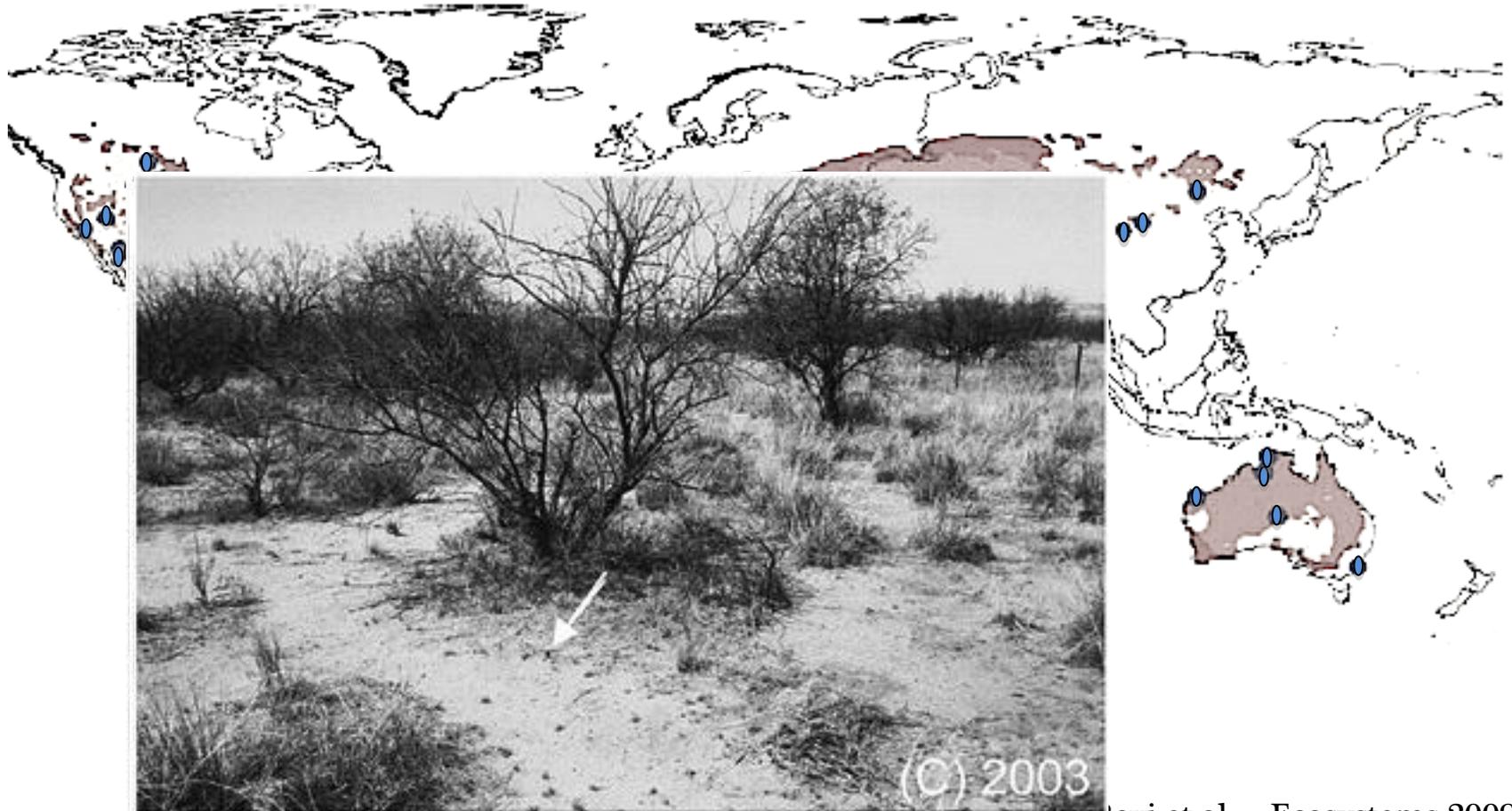
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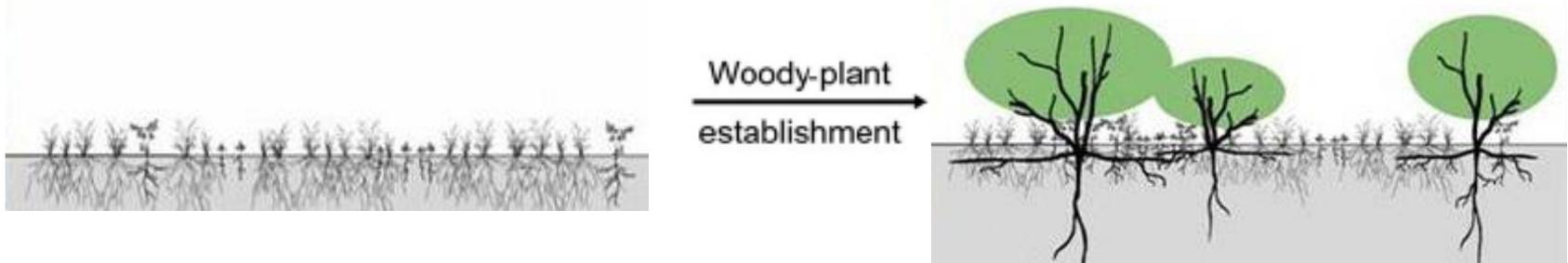
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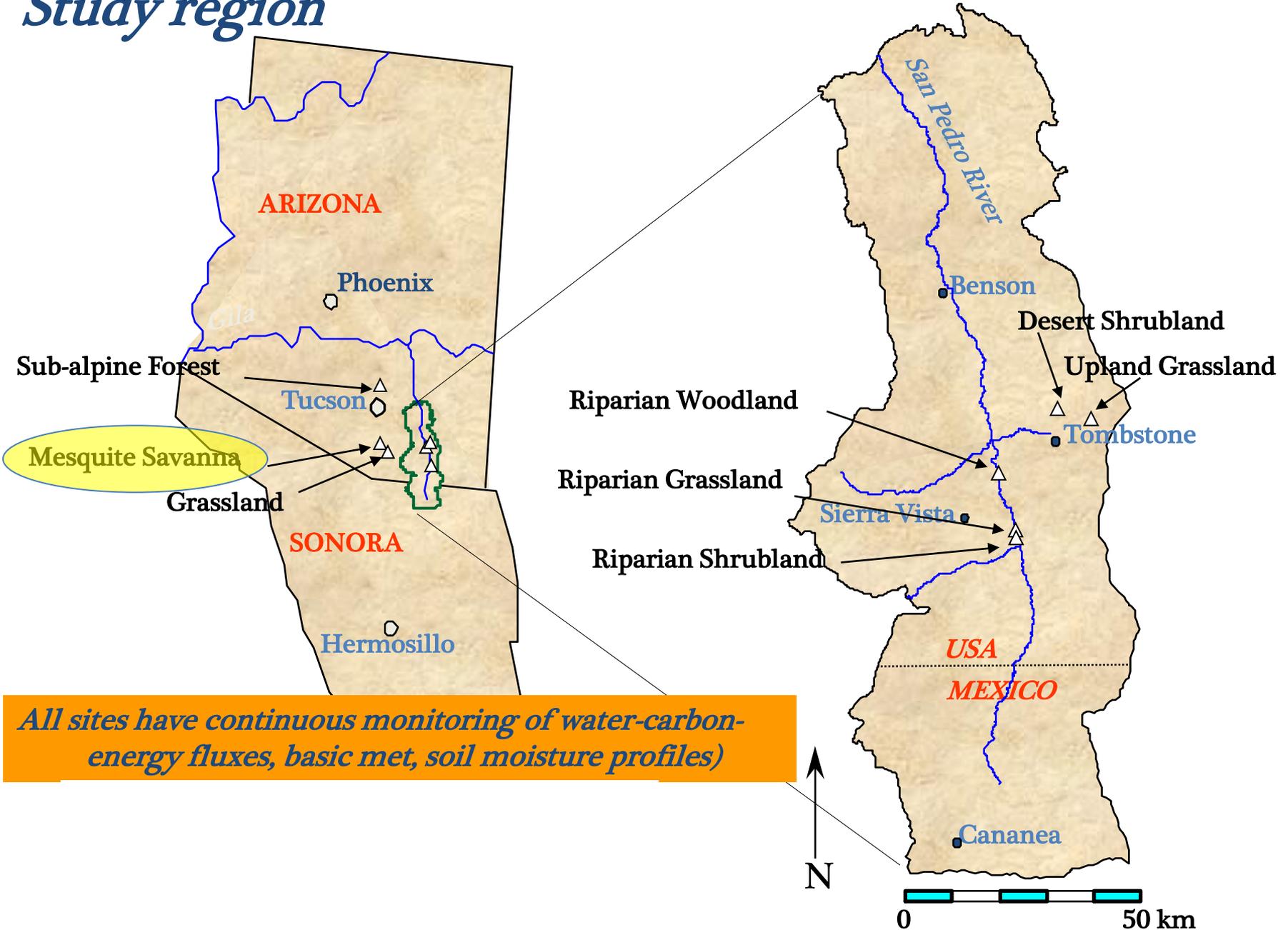
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# WPE results in a mosaic of very different microhabitats



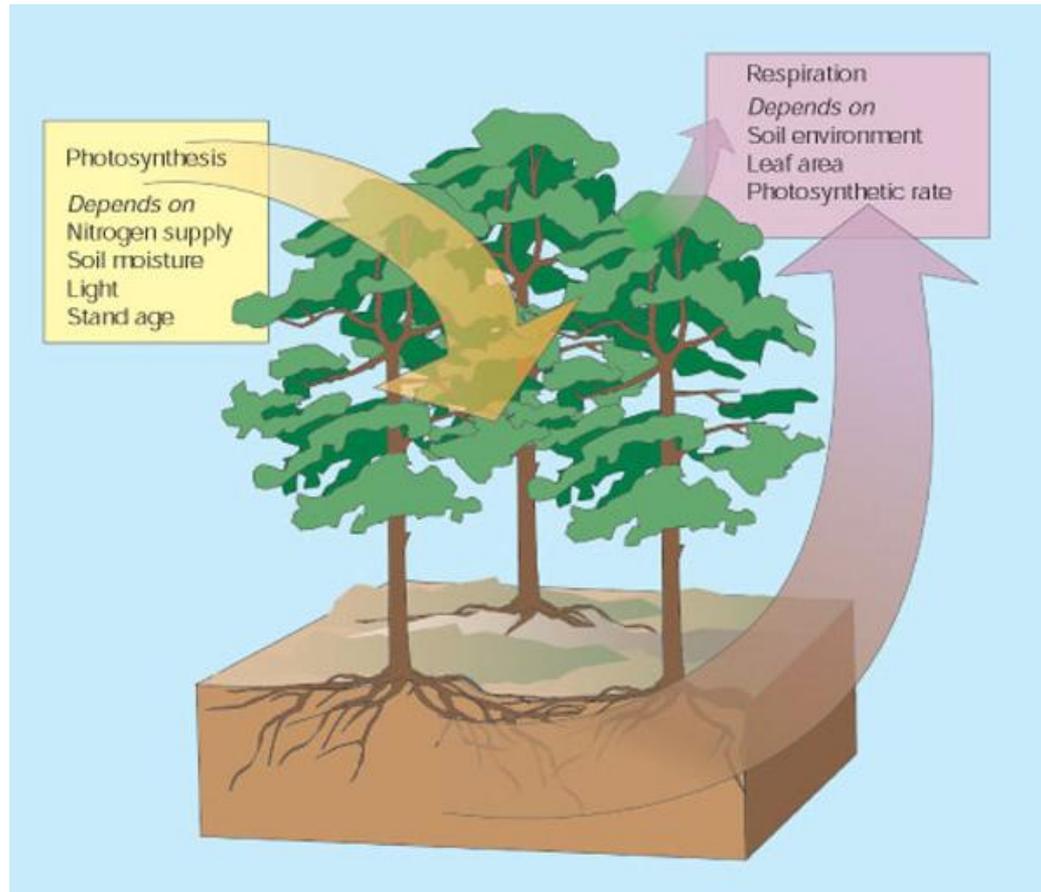
- \* **Reduces incoming solar radiation and reduces soil evaporation rates under trees, but opposite is true in the intercanopy spaces**  
(Breshears et al. 1998; Villegas et al. 2010)
- \* **Increases litter quality/quantity and alters patterns of nutrient availability**  
(McLain et al. 2008; Throop and Archer 2008)
- \* **How do these changes alter patterns of carbon and water cycling?**

# Study region



*All sites have continuous monitoring of water-carbon-energy fluxes, basic met, soil moisture profiles)*

# What are the different CO<sub>2</sub> fluxes within an ecosystem?



*CO<sub>2</sub> uptake:*

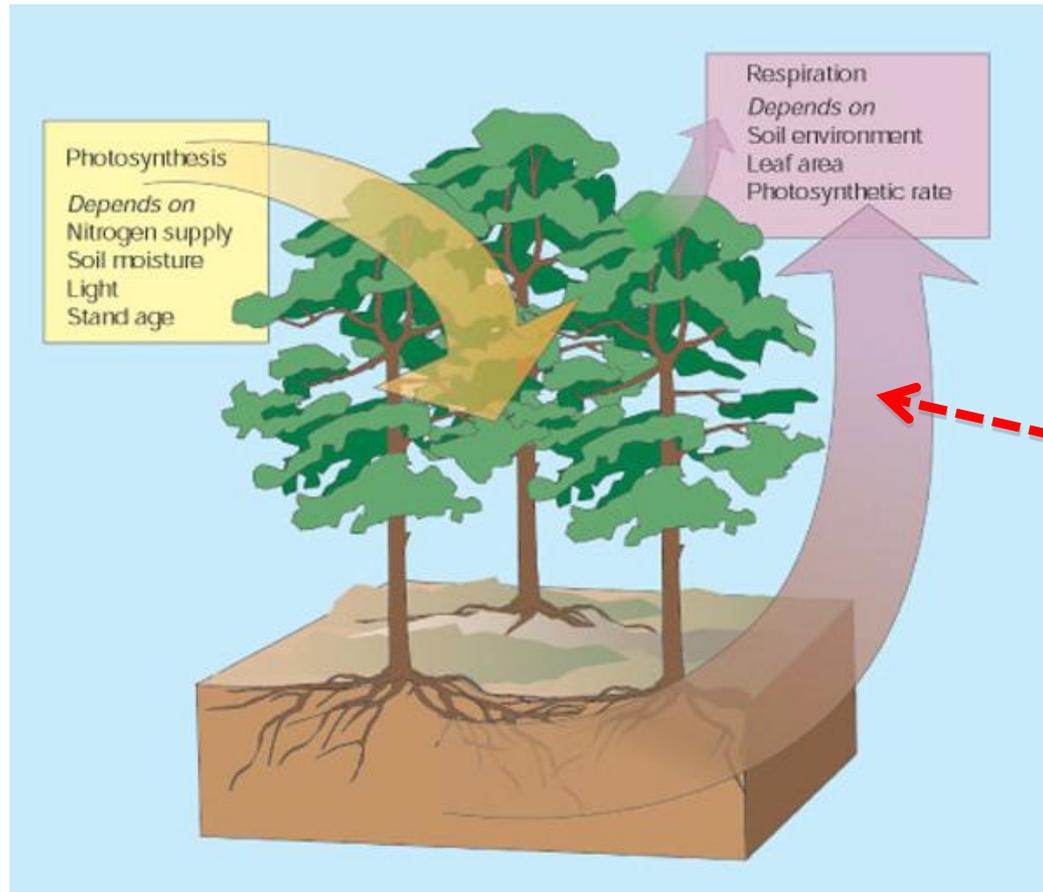
- \* Photosynthesis

*CO<sub>2</sub> efflux:*

- \* Photorespiration
- \* Nighttime leaf respiration
- \* Soil respiration

Chapin and Ruess *Nature* 2001

# What are the different CO<sub>2</sub> fluxes within an ecosystem?



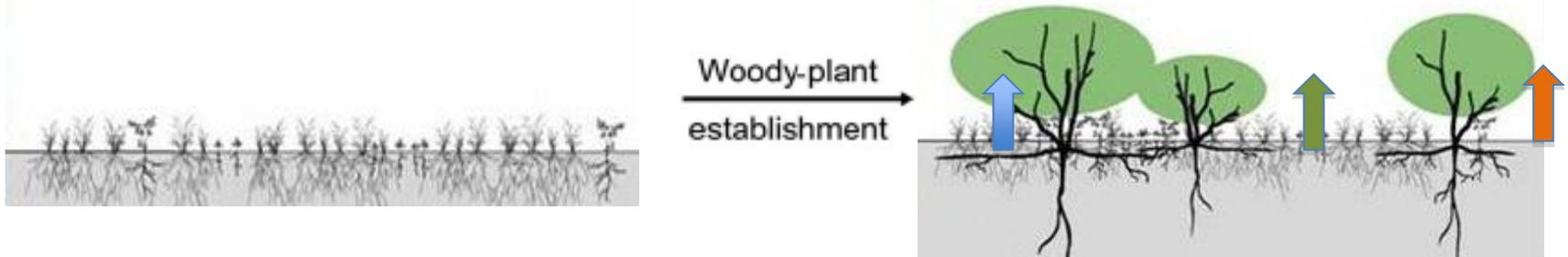
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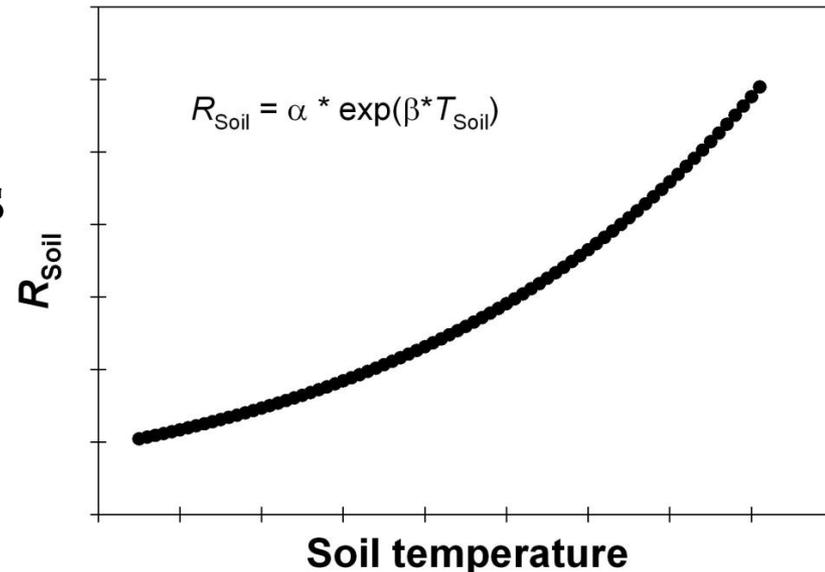
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- \* **Soil respiration**

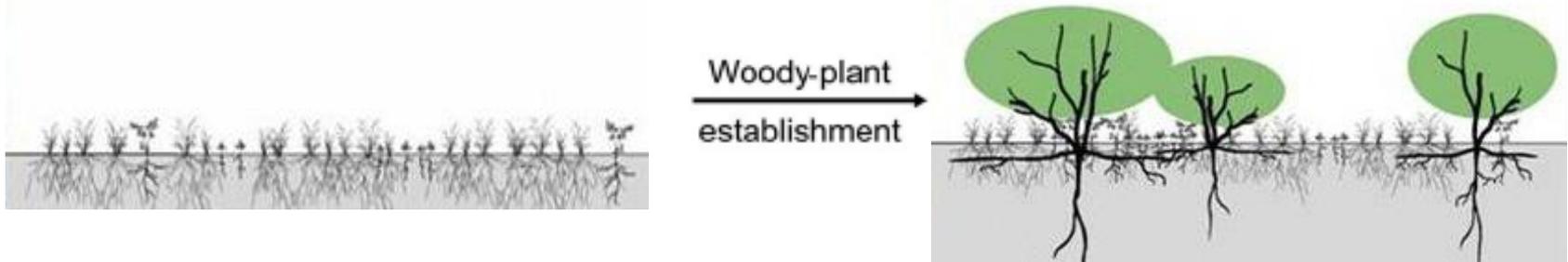
# WPE results in a mosaic of microhabitats of differing soil conditions and litter quality



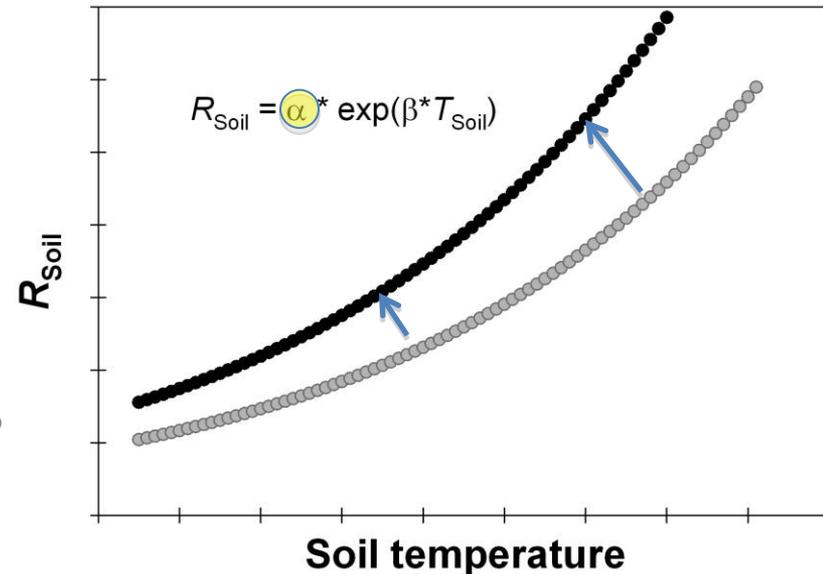
- How do these different microhabitats differ in their base rates of soil respiration?
- Do they differ in their responses to pulses of soil moisture?
- Do they differ in their sensitivity to soil temperature?



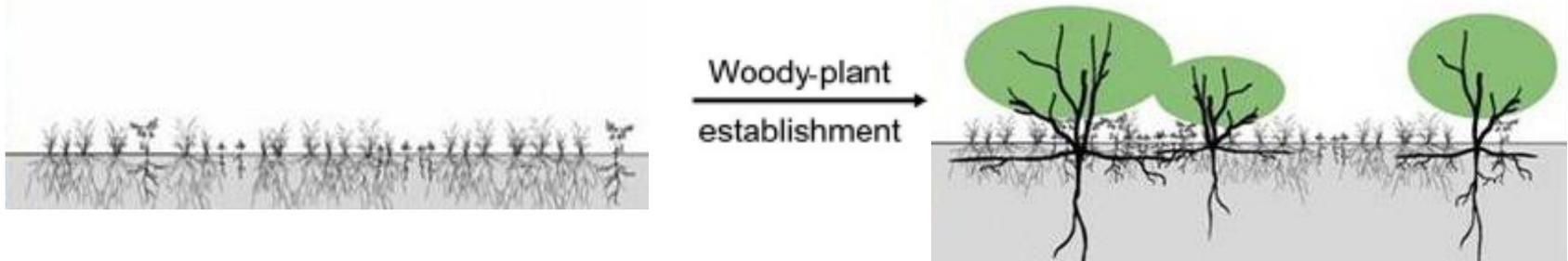
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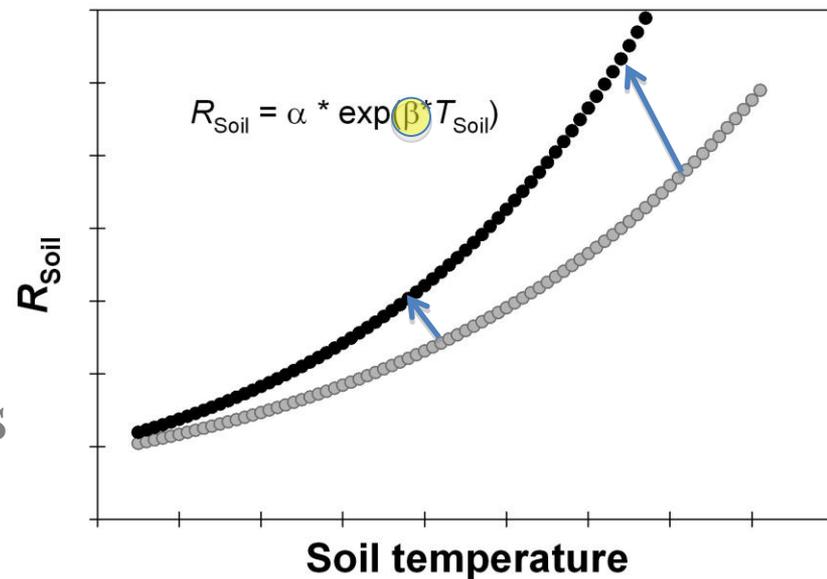
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# WPE results in a mosaic of microhabitats of differing soil conditions and litter quality



- How do these different microhabitats differ in their base rates of soil respiration?
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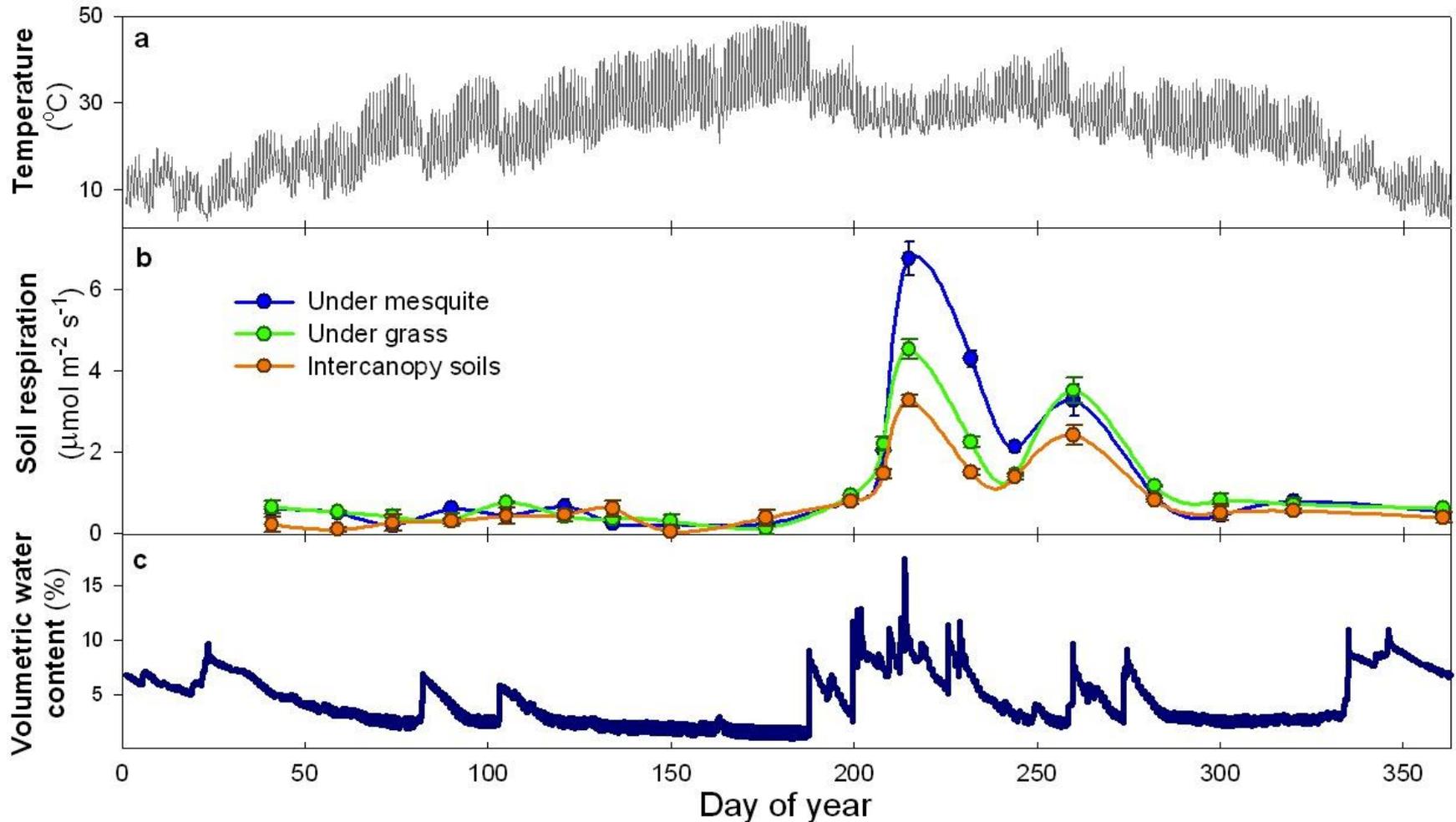
# Mesquite savannah site

~ illustration of measurement locations



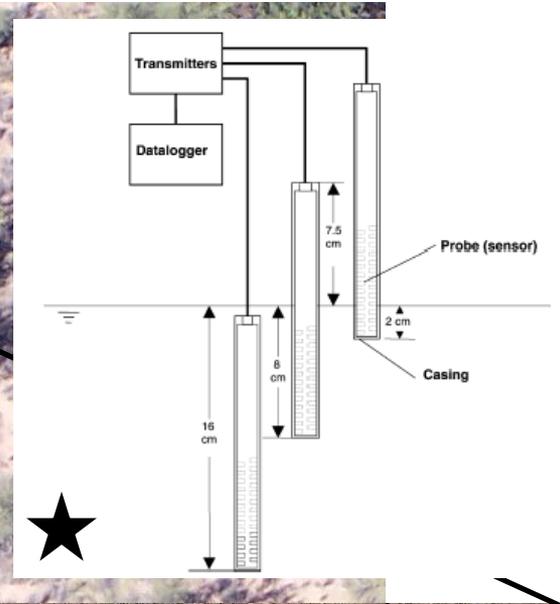
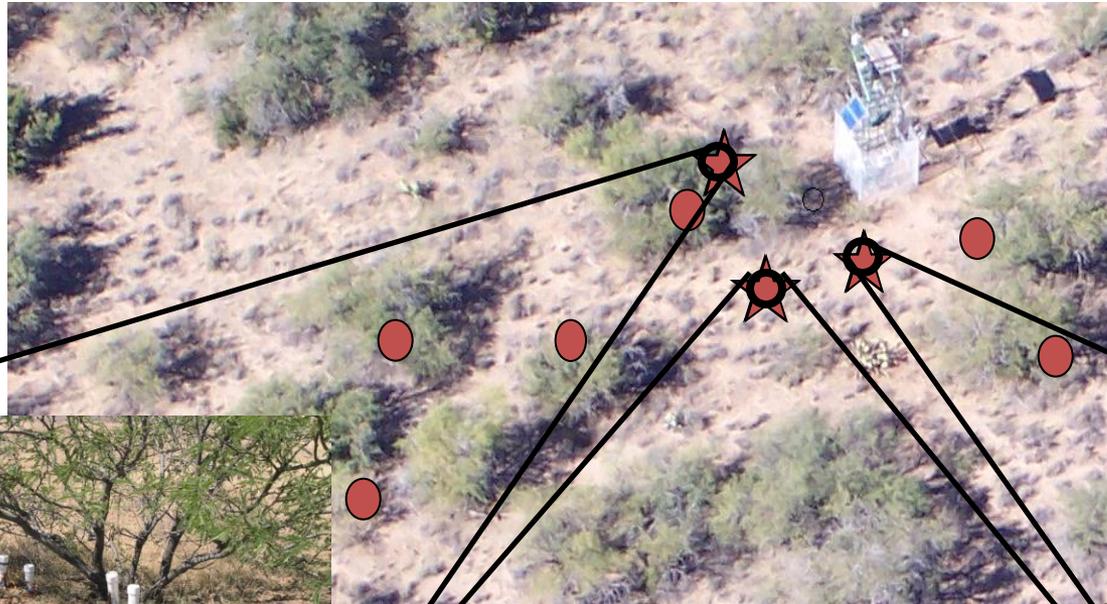
# What are the relative controls of temperature and soil moisture on soil CO<sub>2</sub> efflux under a **changing landscape**?

When wet, mesquite > grass > intercanopy soils

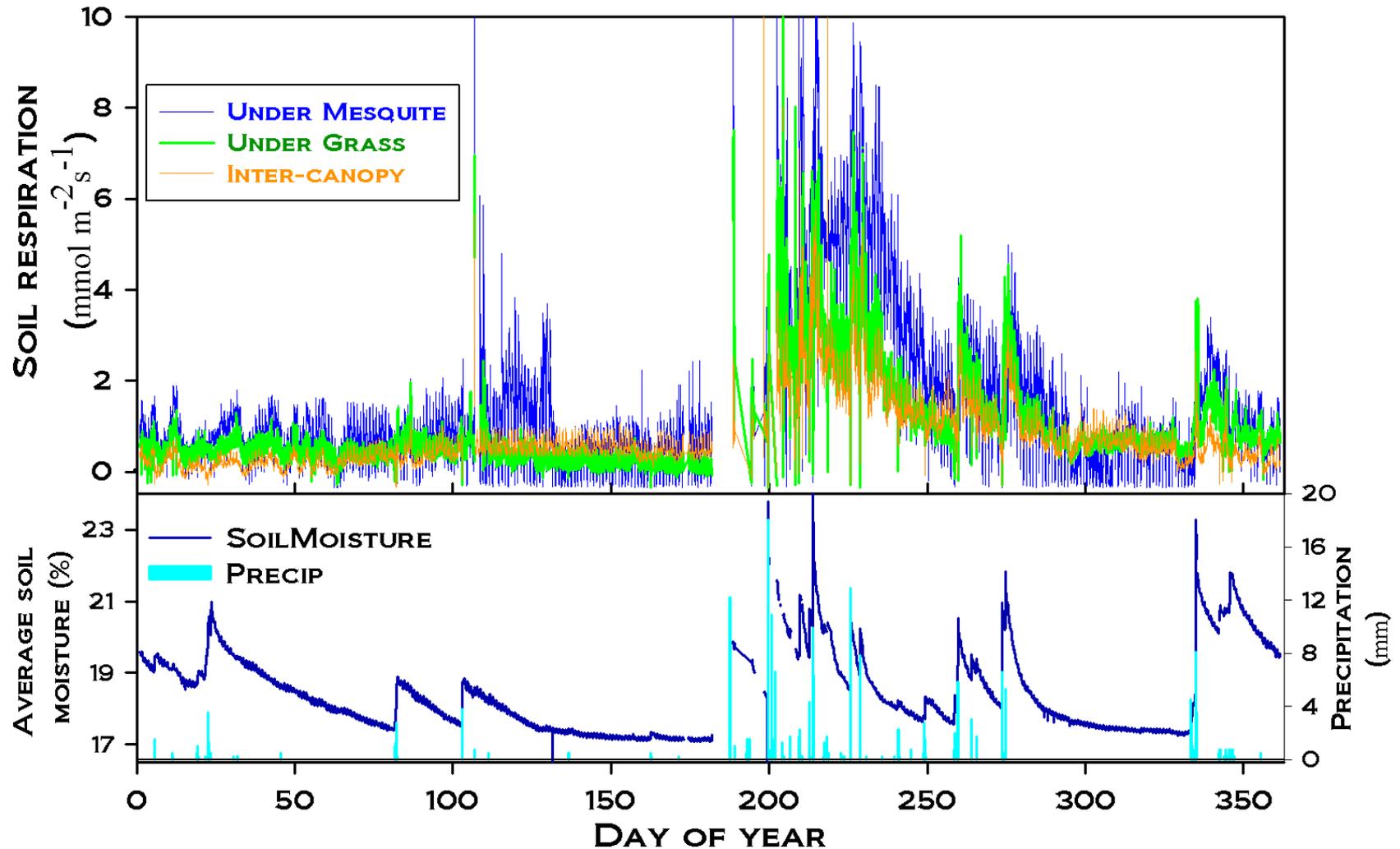


# Mesquite savannah site

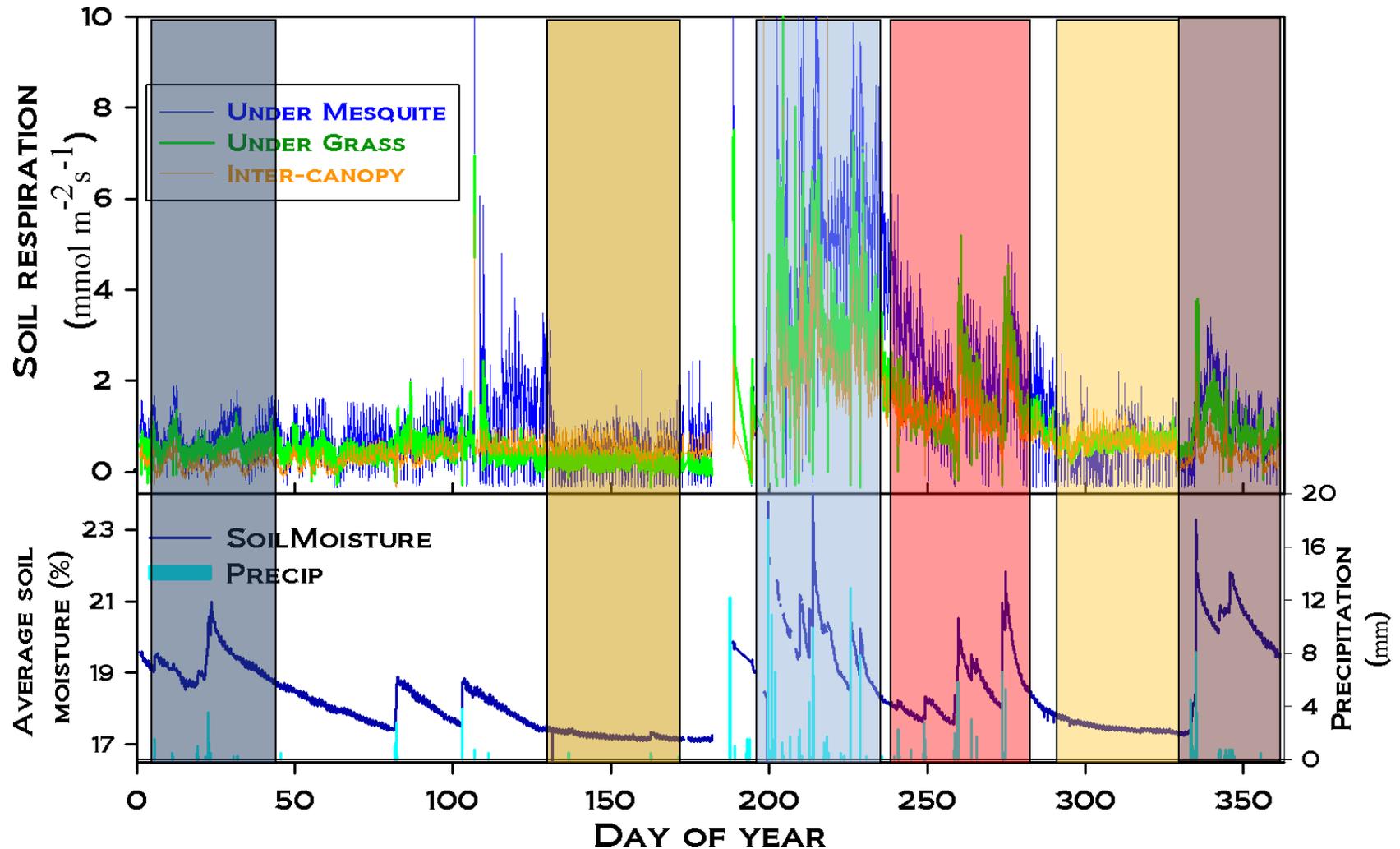
~ Continuous measurement systems



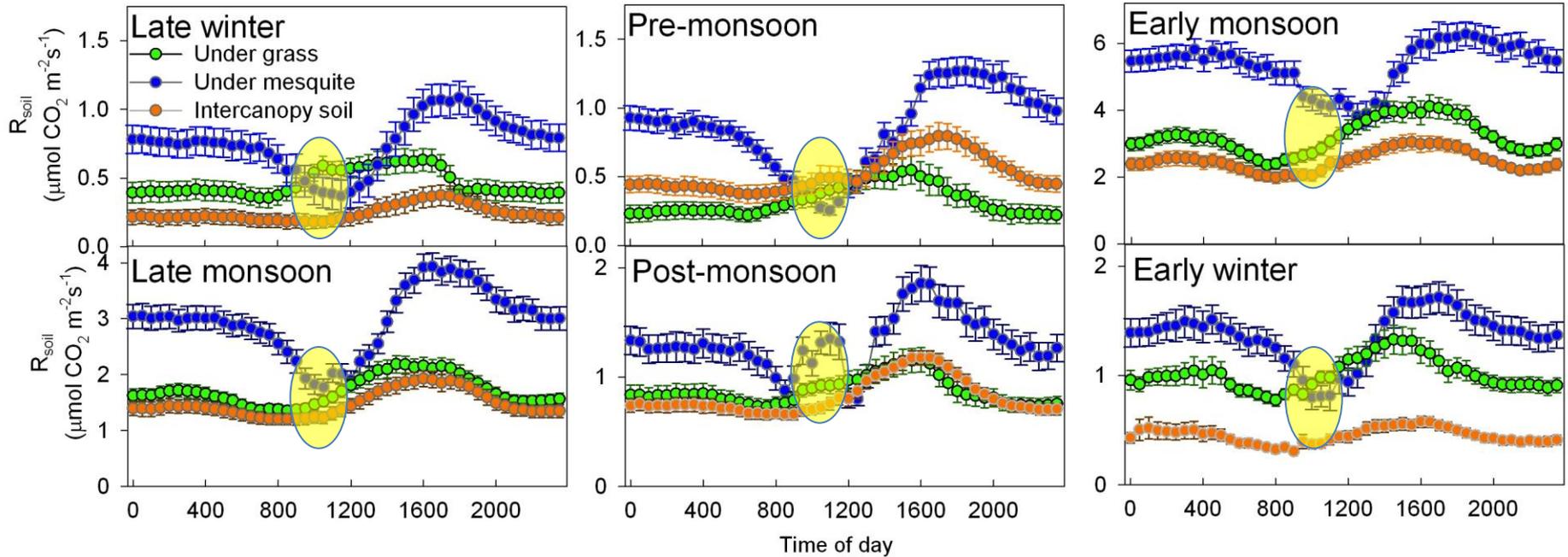
# Soil respiration varies throughout a year and differentially among microhabitats:



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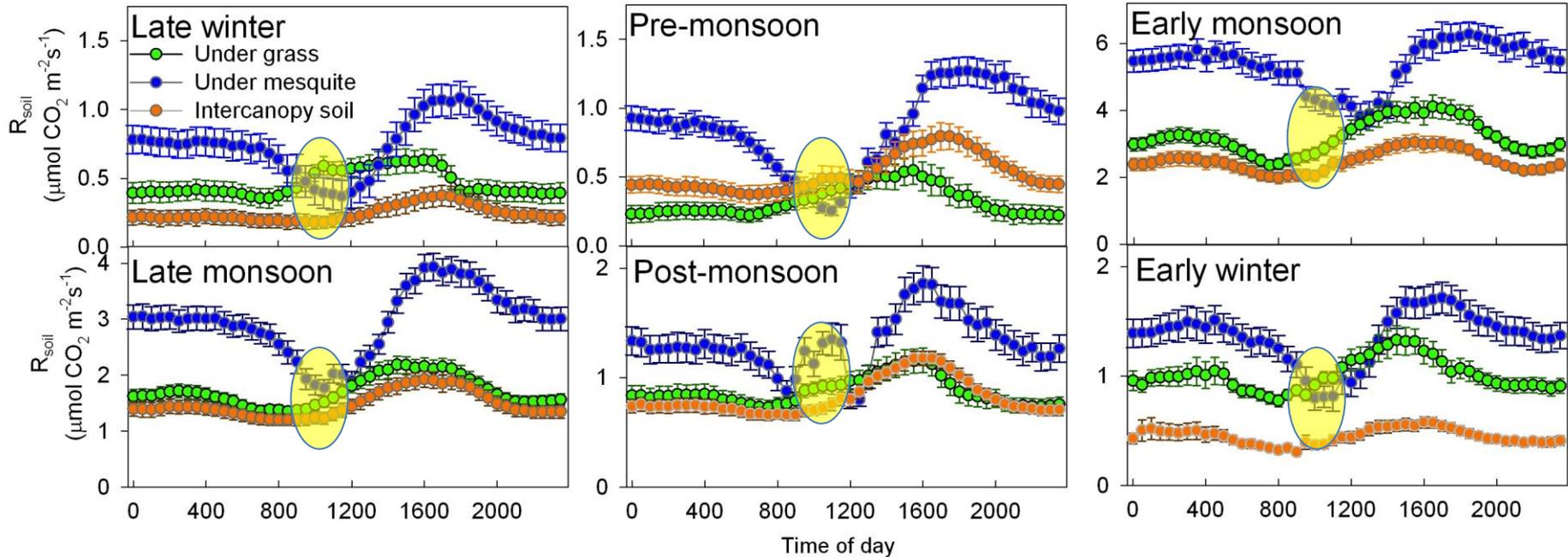
# High temporal resolution data illuminates so many more interesting patterns...



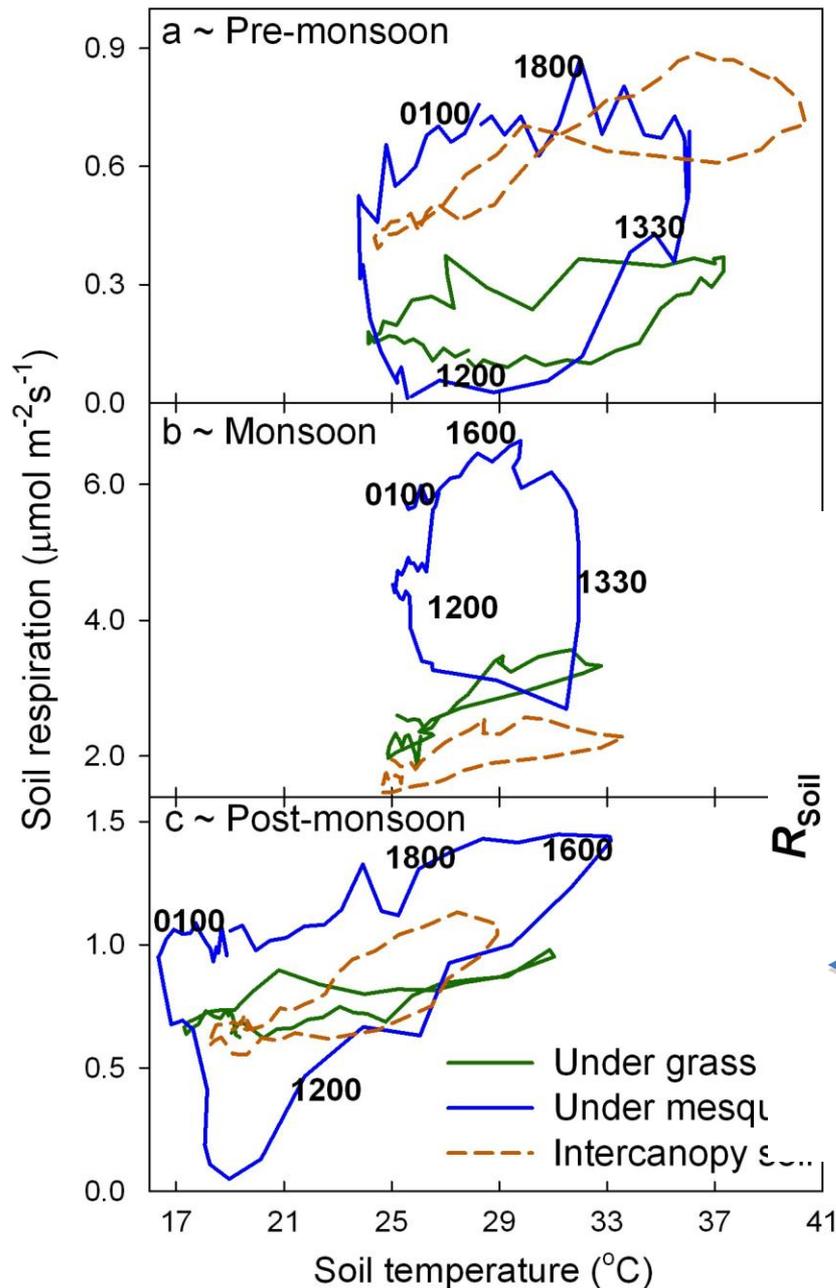
\*  $R_{\text{Soil}}$  under mesquite is nearly always greatest

\*  $R_{\text{Soil}}$  under mesquite experienced this midday depression

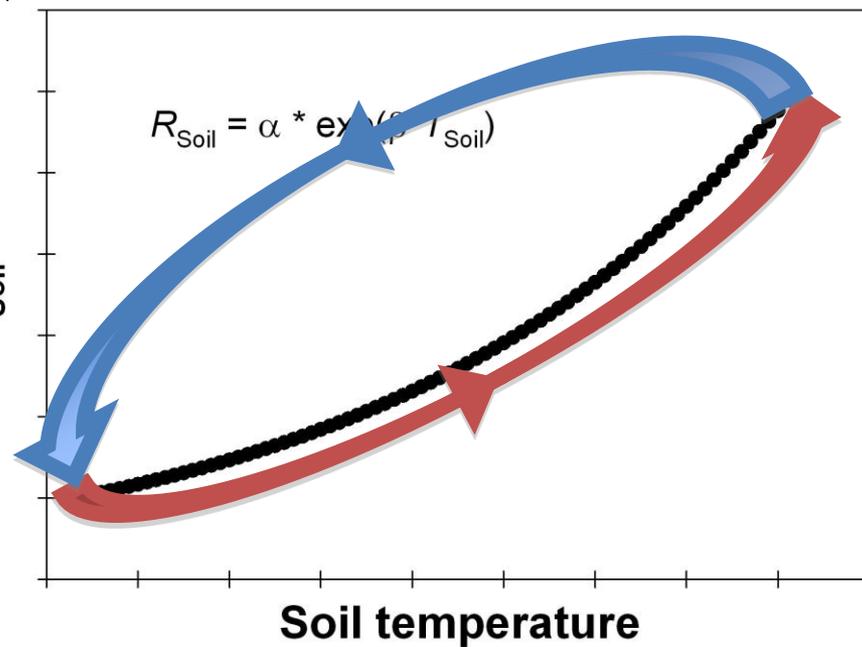
# So, why didn't we see these microhabitat differences across all seasons before???



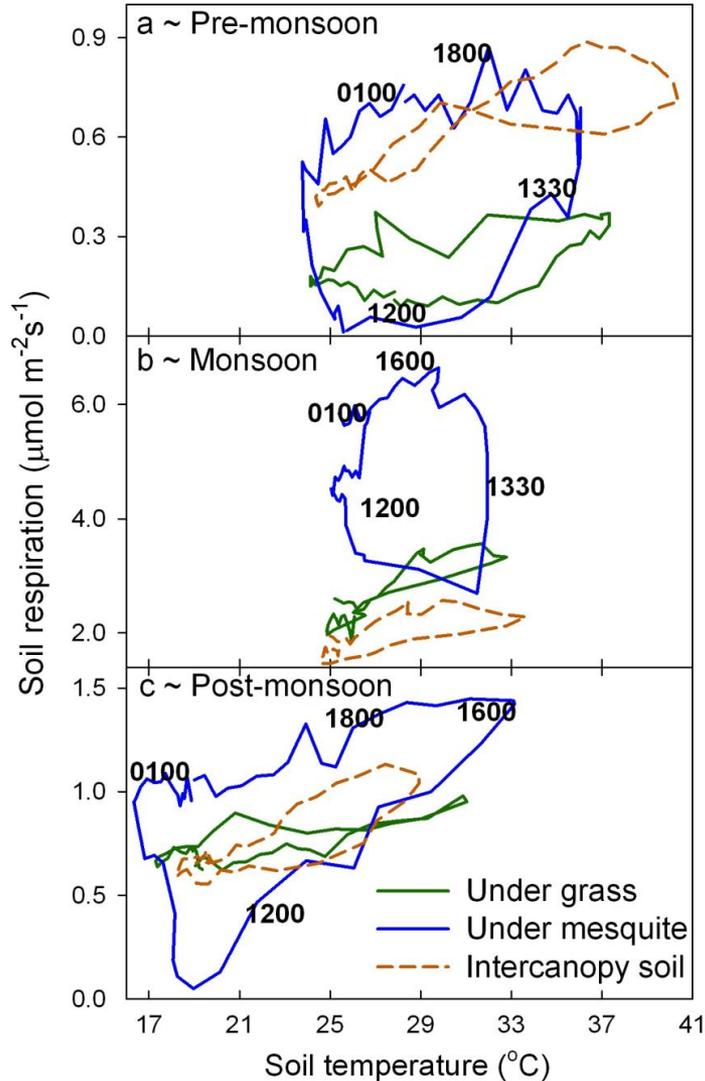
• Traditional measurements in the early morning were only telling us a small portion of the story



There is a hysteretic relationship between soil temperature and  $R_{\text{Soil}}$  (this will seriously complicate extrapolations)



# Summary :



\* There is a hysteretic relationship between soil temperature and  $R_{\text{Soil}}$  that complicates extrapolations among scales

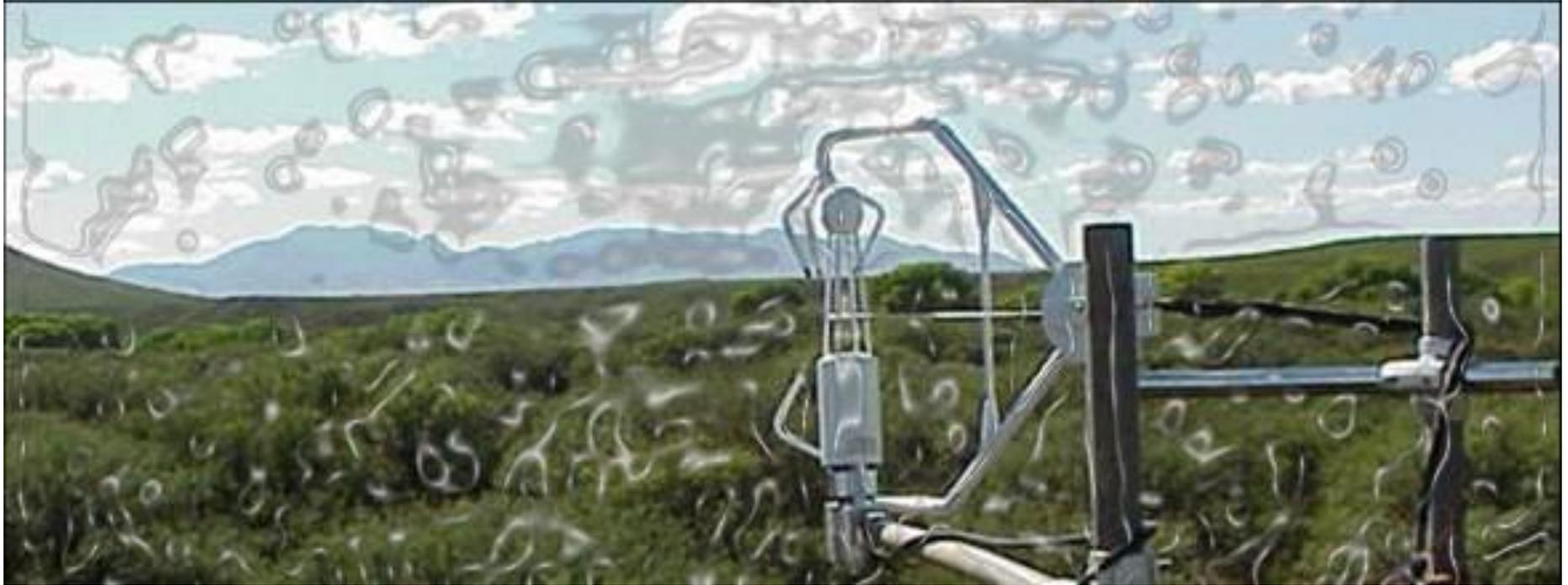
\* Presence of woody plants in this landscape yields ( $\sim 2\text{X}$ ) greater rates of  $\text{CO}_2$  efflux from the soil (412 vs 230  $\text{gC m}^{-2}\text{ year}$ )

\* As grasslands transition to shrub dominance, the contribution of  $R_{\text{Soil}}$  to net ecosystem carbon flux will increase, dramatically shifting the carbon balance of semiarid regions

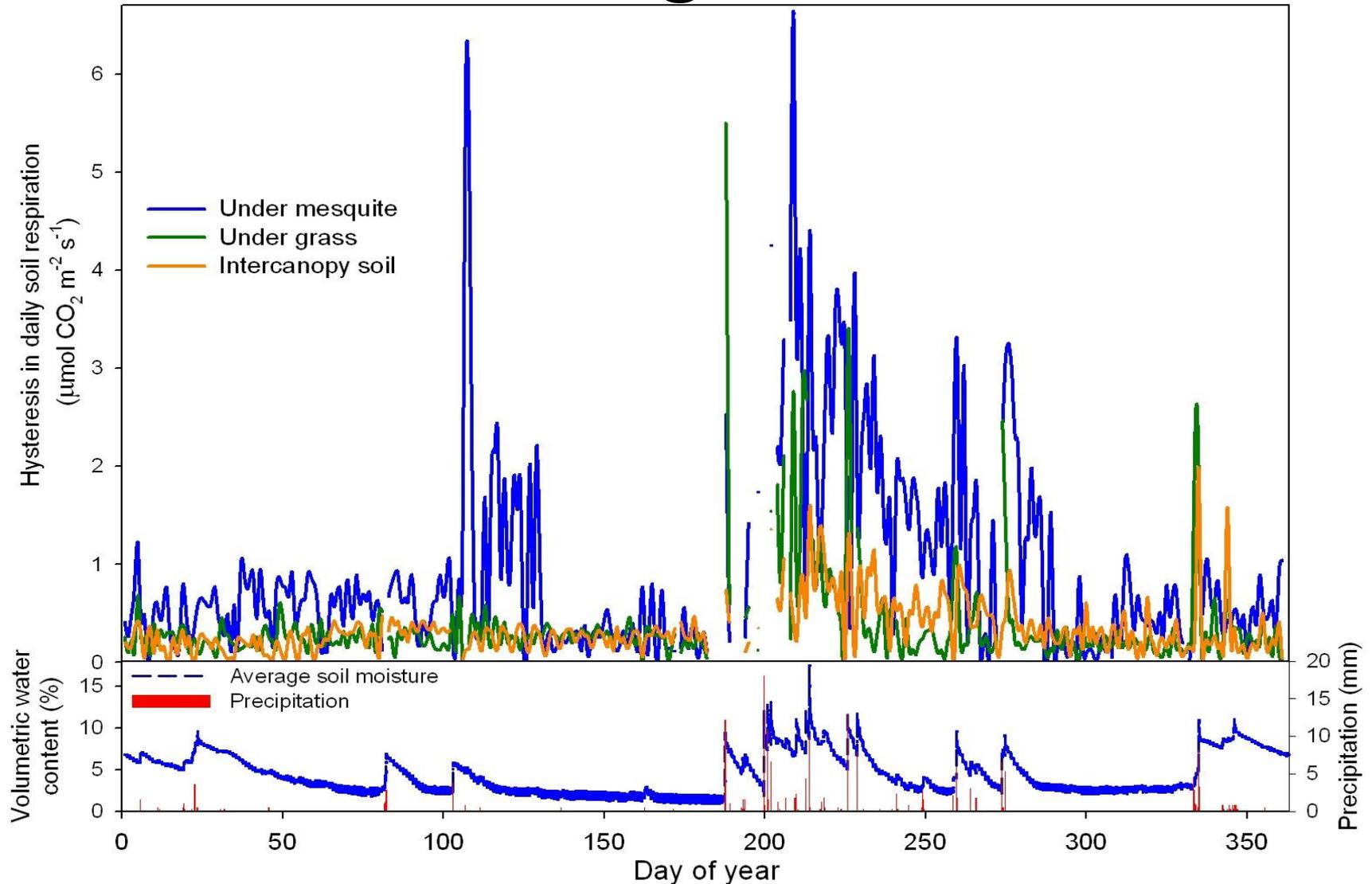
# The next steps...



# Questions?

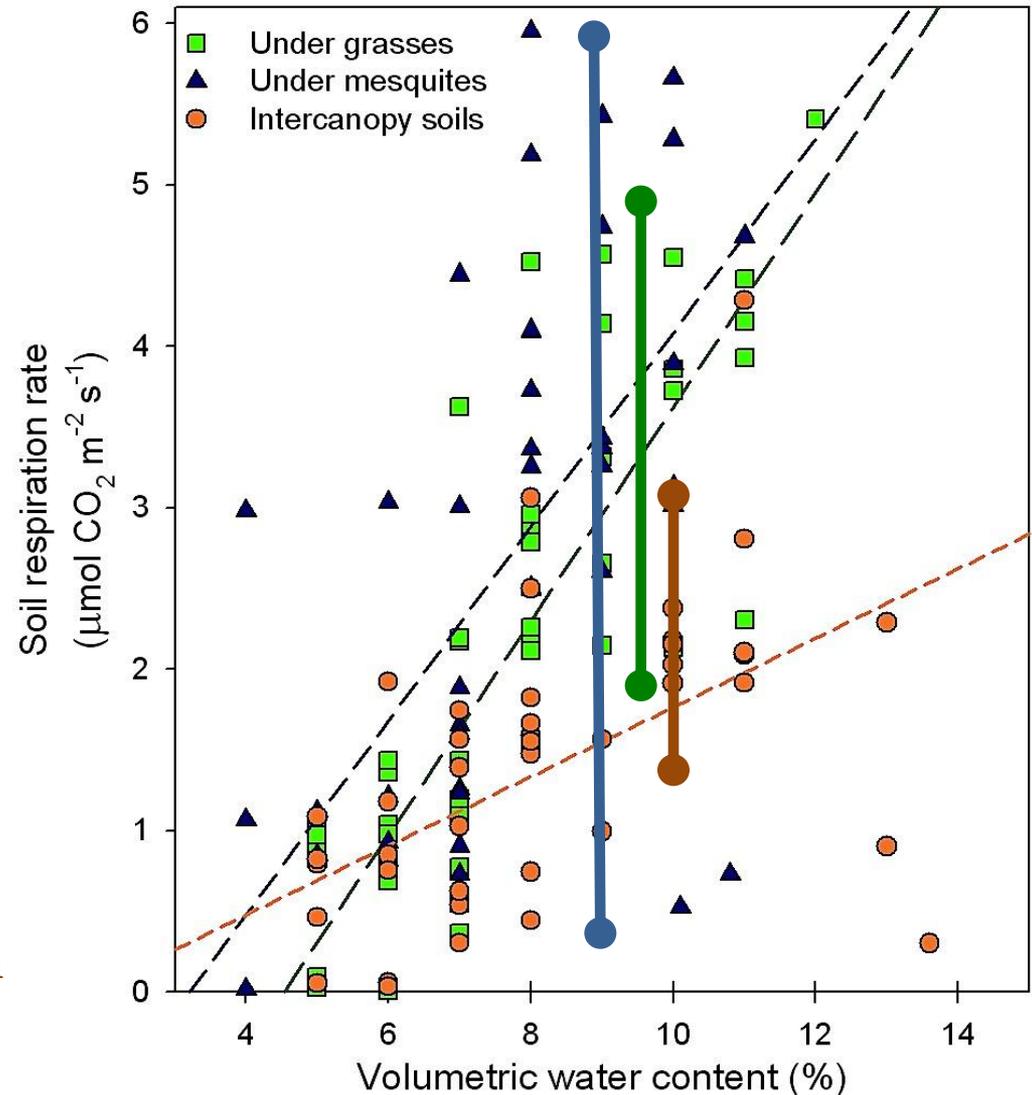


# The degree of hysteresis is dynamic and differs among microhabitats:

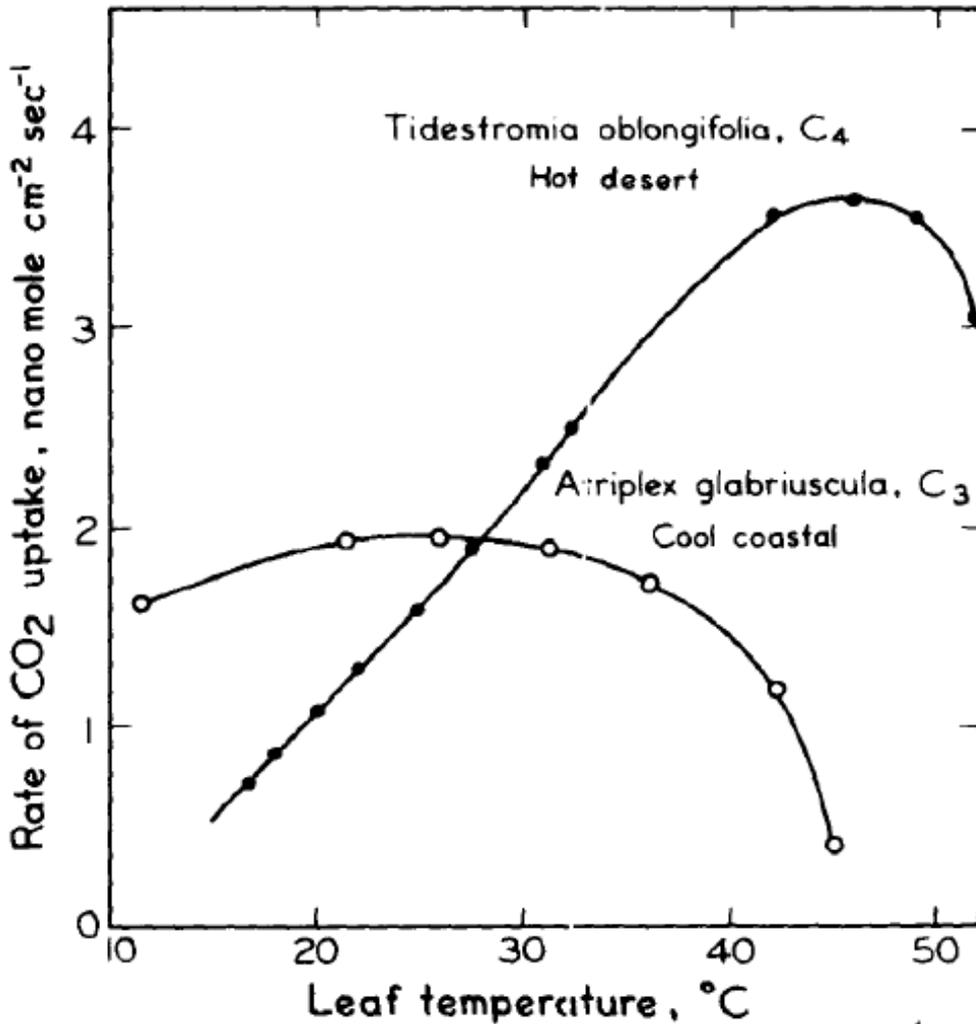


# What are the relative controls of temperature and soil moisture on soil CO<sub>2</sub> efflux under a changing landscape?

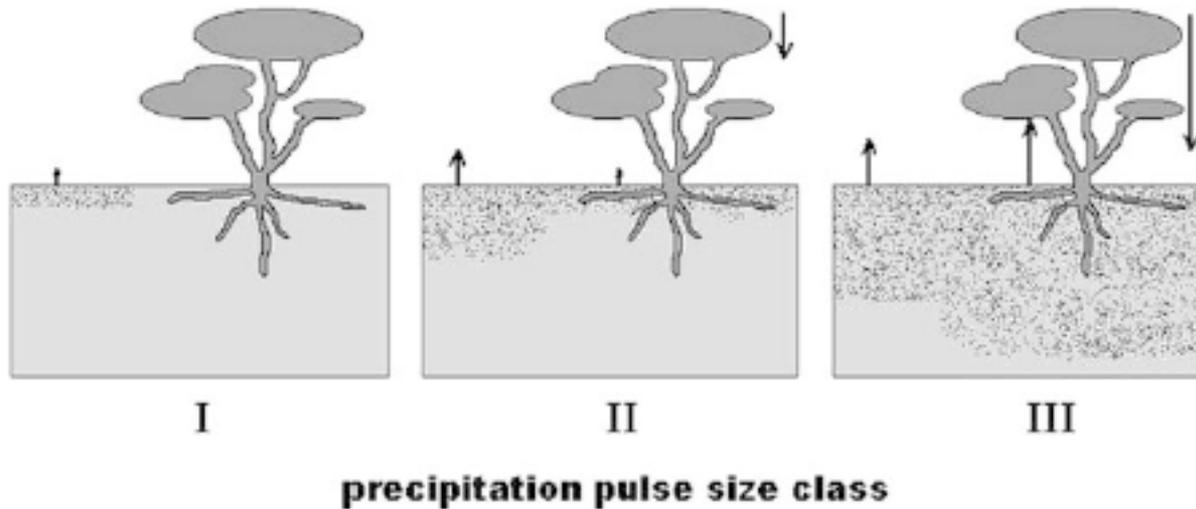
- Soil respiration under mesquites and grasses are highly responsive to increases in soil moisture
- BUT
- There is a lot of variability in soil respiration rates at each level of VWC
- SO
- Moisture content is a poor predictor for soil respiration



Berry & Bjorkman have known temperature was important for at least 30 years!

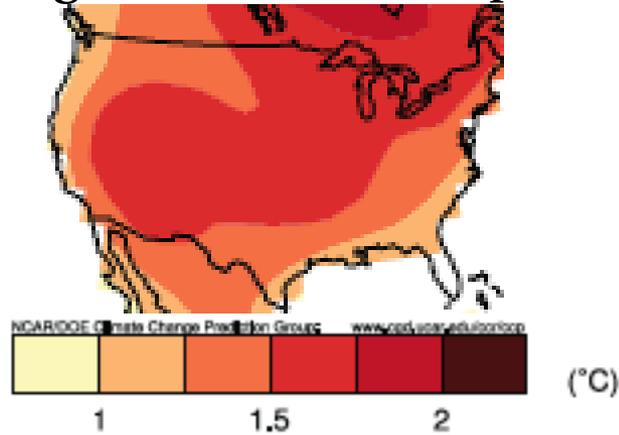


# The size of the precipitation event influences the size and direction of the biological response

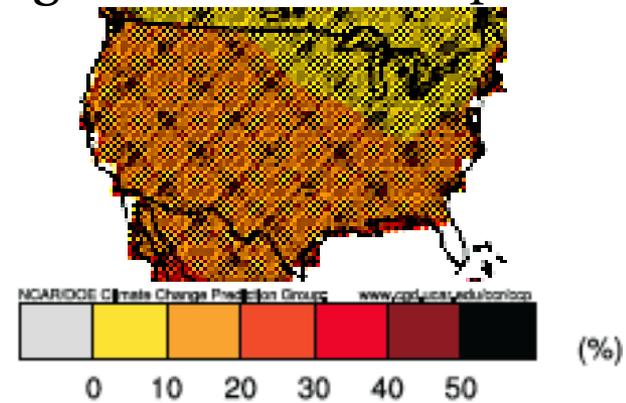


# Our climate is getting warmer...

Change in surface air temperature:



Change in surface air temperature:



... and drier, with more variable precipitation

