Ecosystem response to precipitation pulses in the Sonoran Desert

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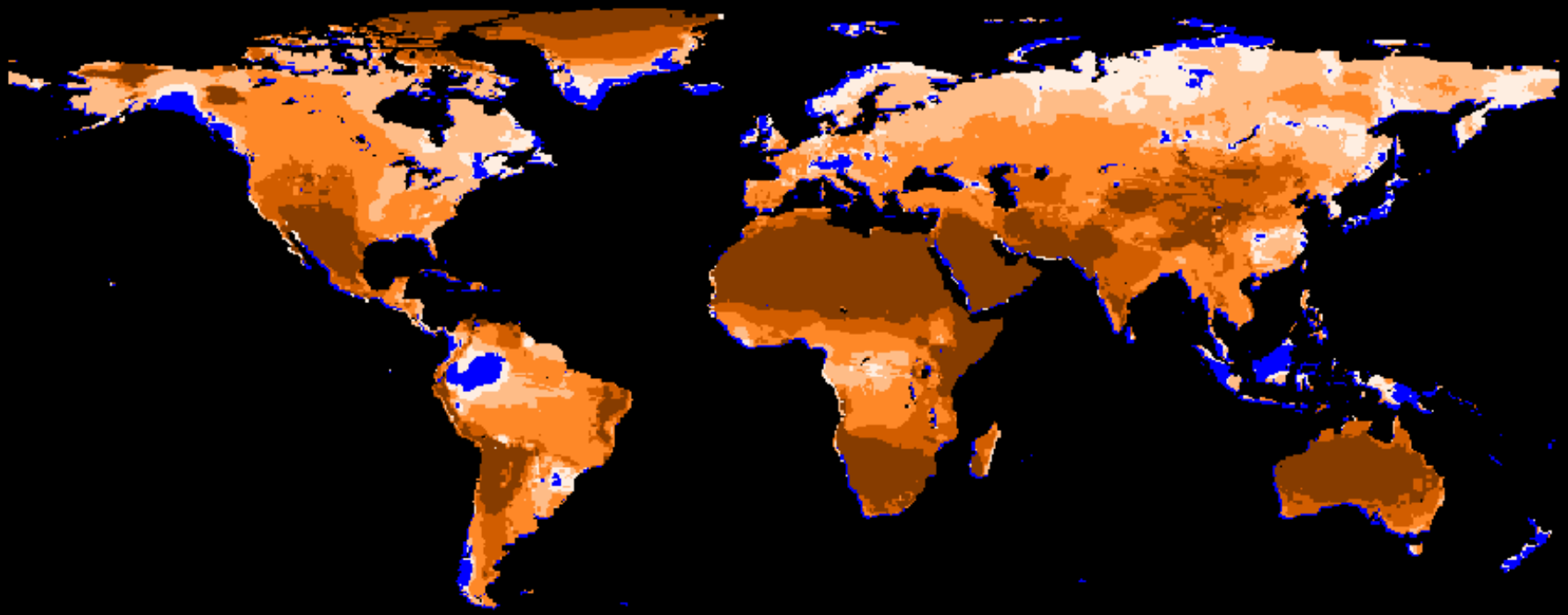
PRADA

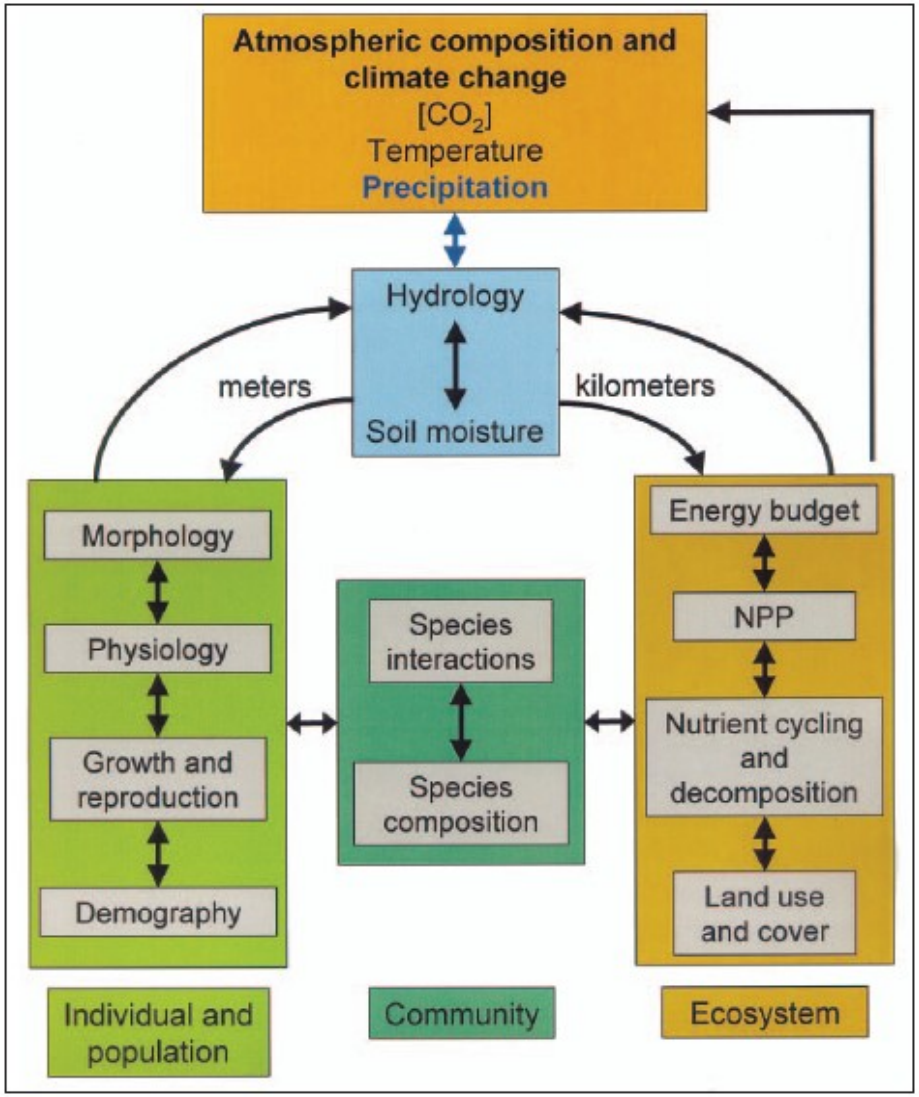
Terrestrial Water Limitation



Number of Months where Precipitation < Potential Evapotranspiration
Blue = Never
Darker Orange = Increasing number of months (1-12)

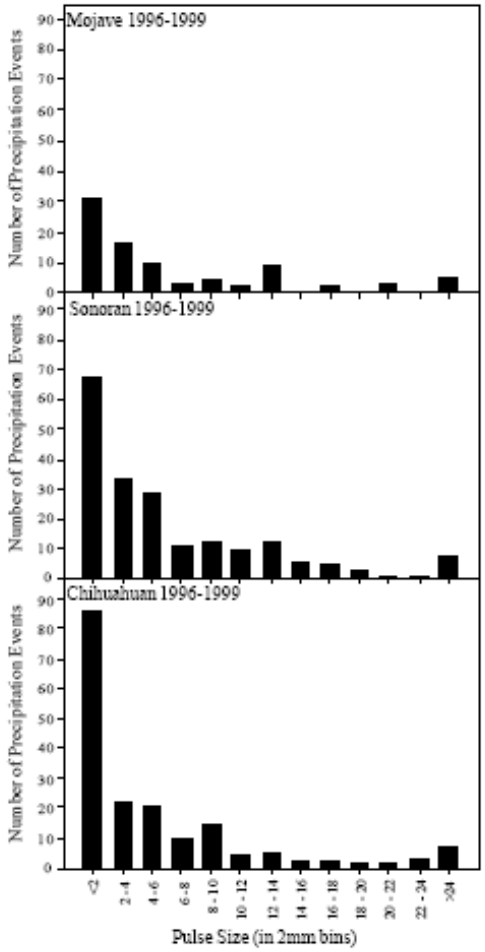
Data from Ahn and Tateishi 1994; Cramer on going

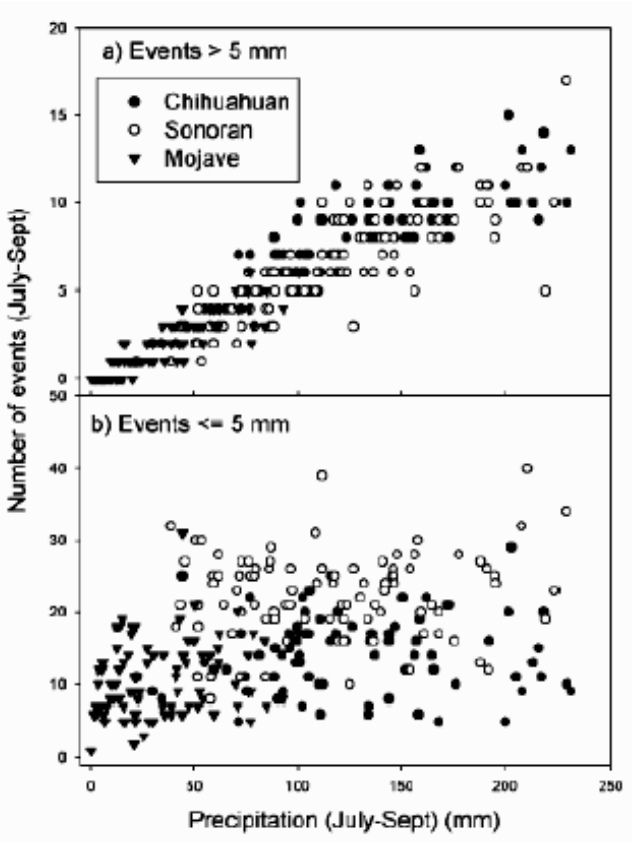
A focus on precipitation?



Integrating nature of landscape water balance with respect to shifts in ecology or climate

Weltzin et al., (2001) *BioScience*





Problem of water availability and biological processes

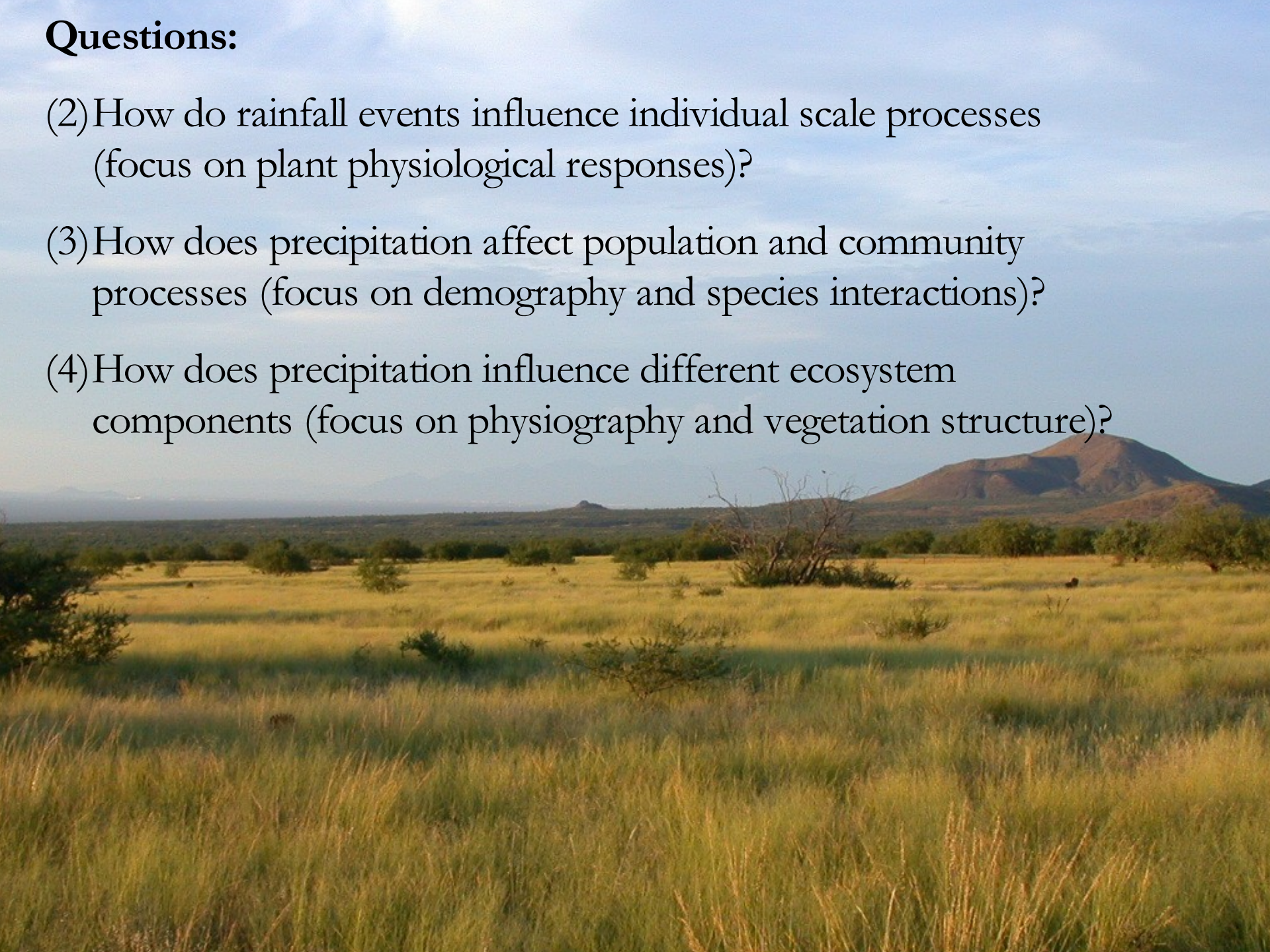
- Discrete nature of rainfall events
- Size – frequency relationships
- Size – seasonal total relationships
- Size – infiltration relationships

Questions:

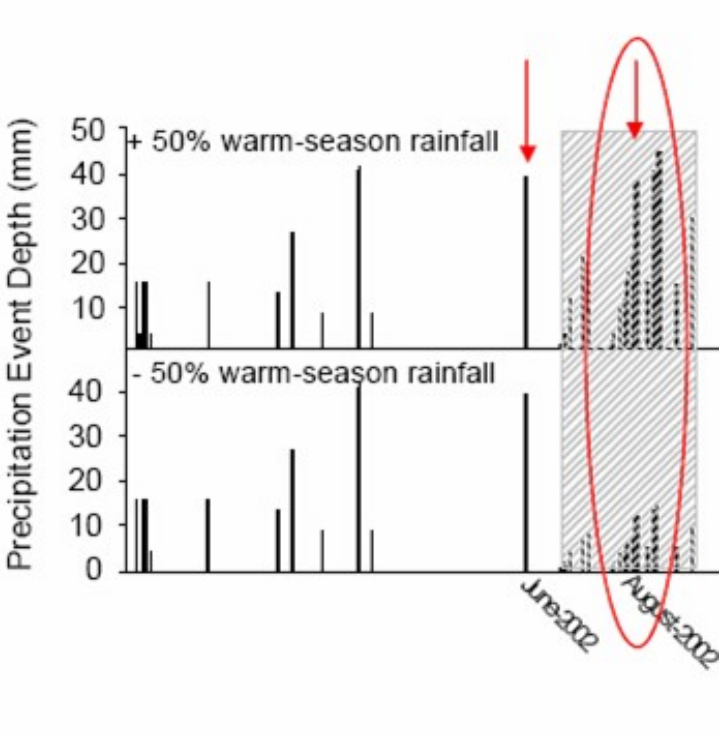
(2) How do rainfall events influence individual scale processes (focus on plant physiological responses)?

(3) How does precipitation affect population and community processes (focus on demography and species interactions)?

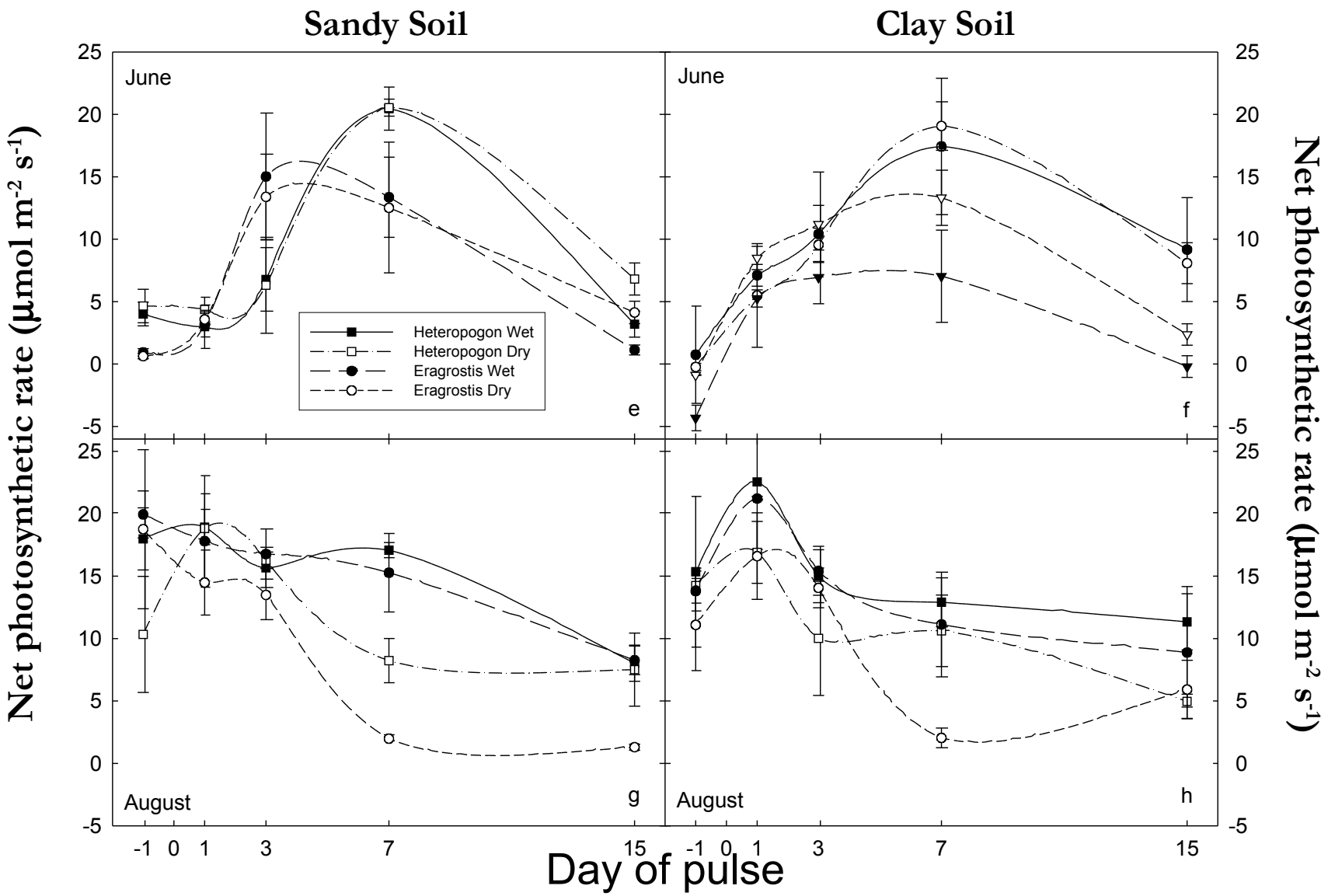
(4) How does precipitation influence different ecosystem components (focus on physiography and vegetation structure)?



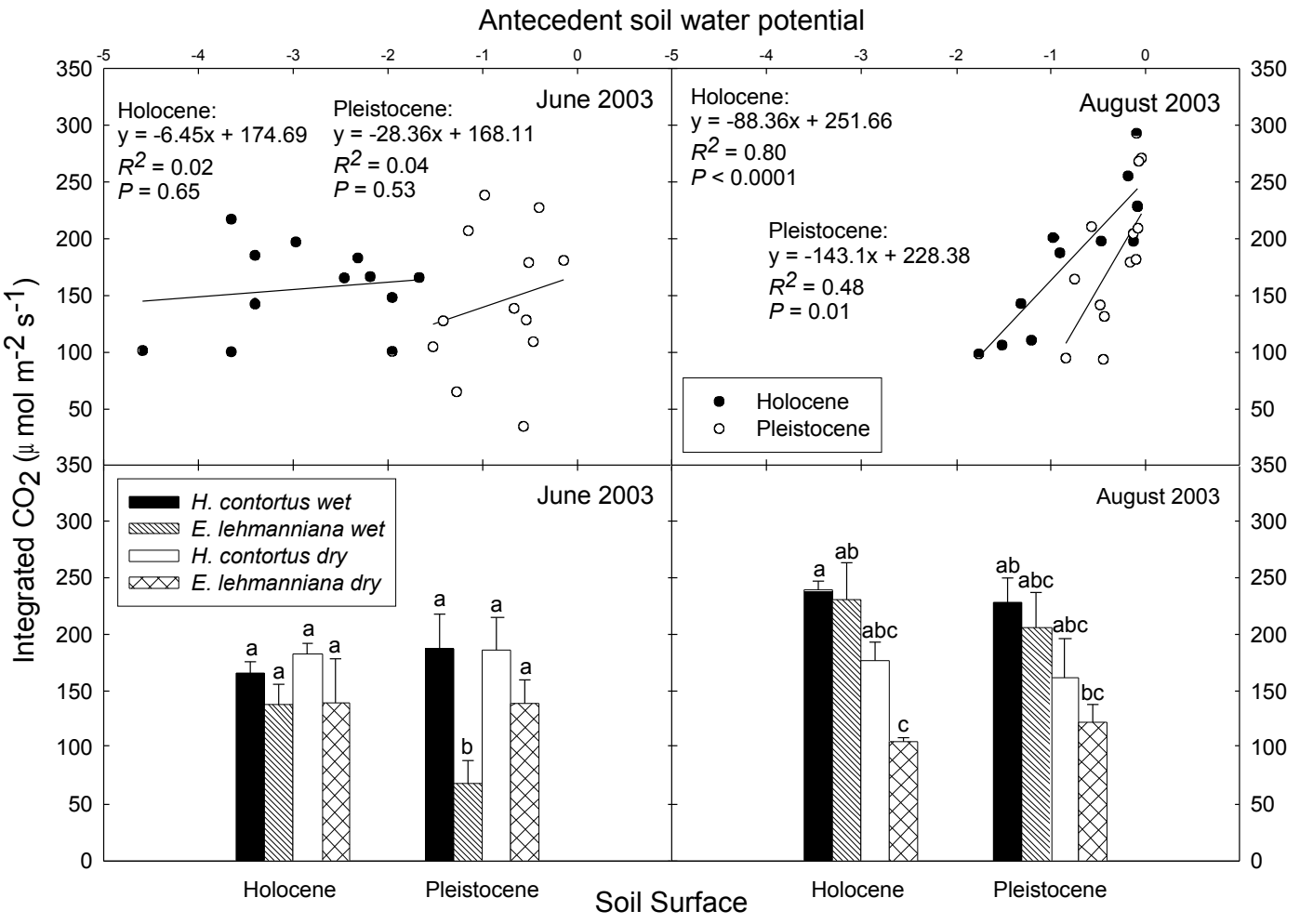
Pulses and carbon / water cycling



Photosynthetic responses of plant following a rainfall event

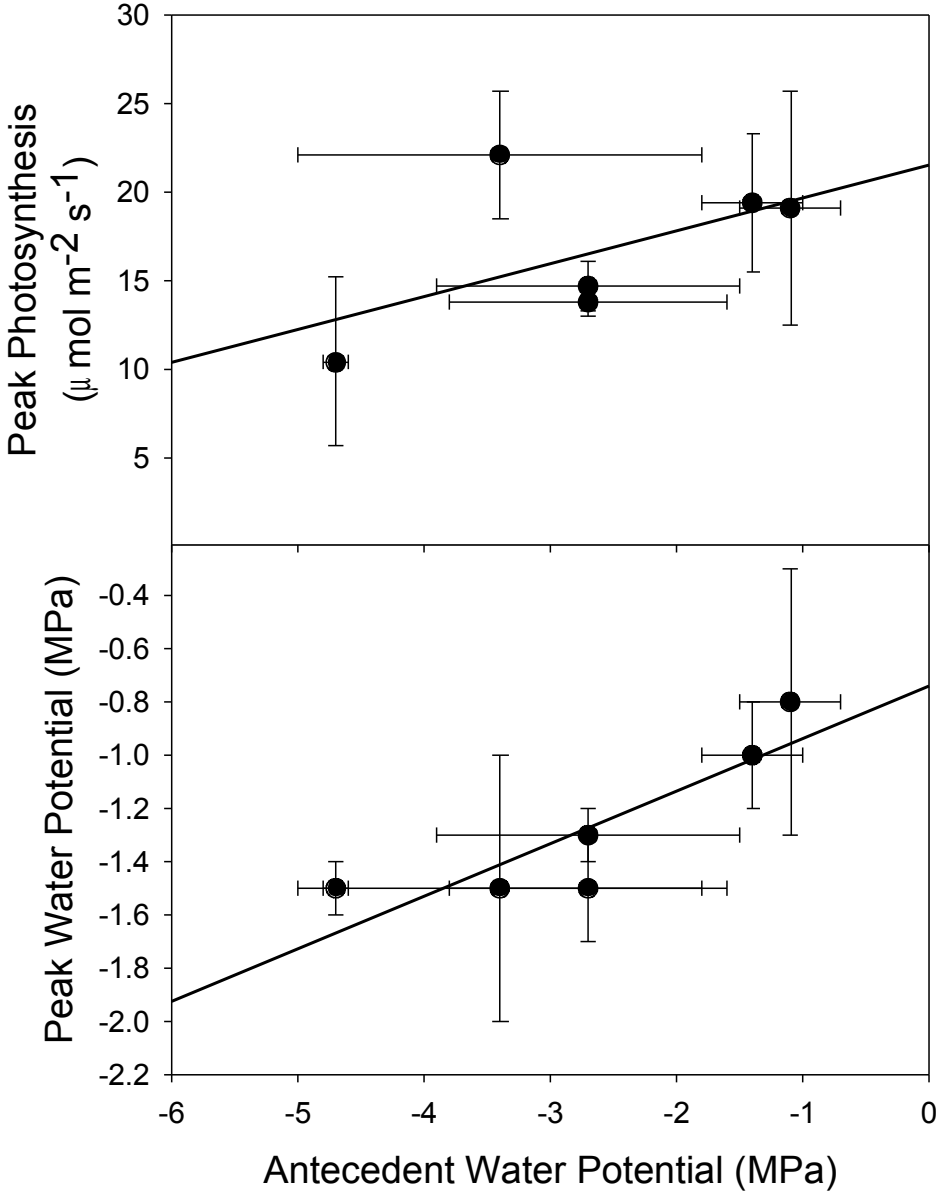


Predicting patterns of 'pulse' carbon gain

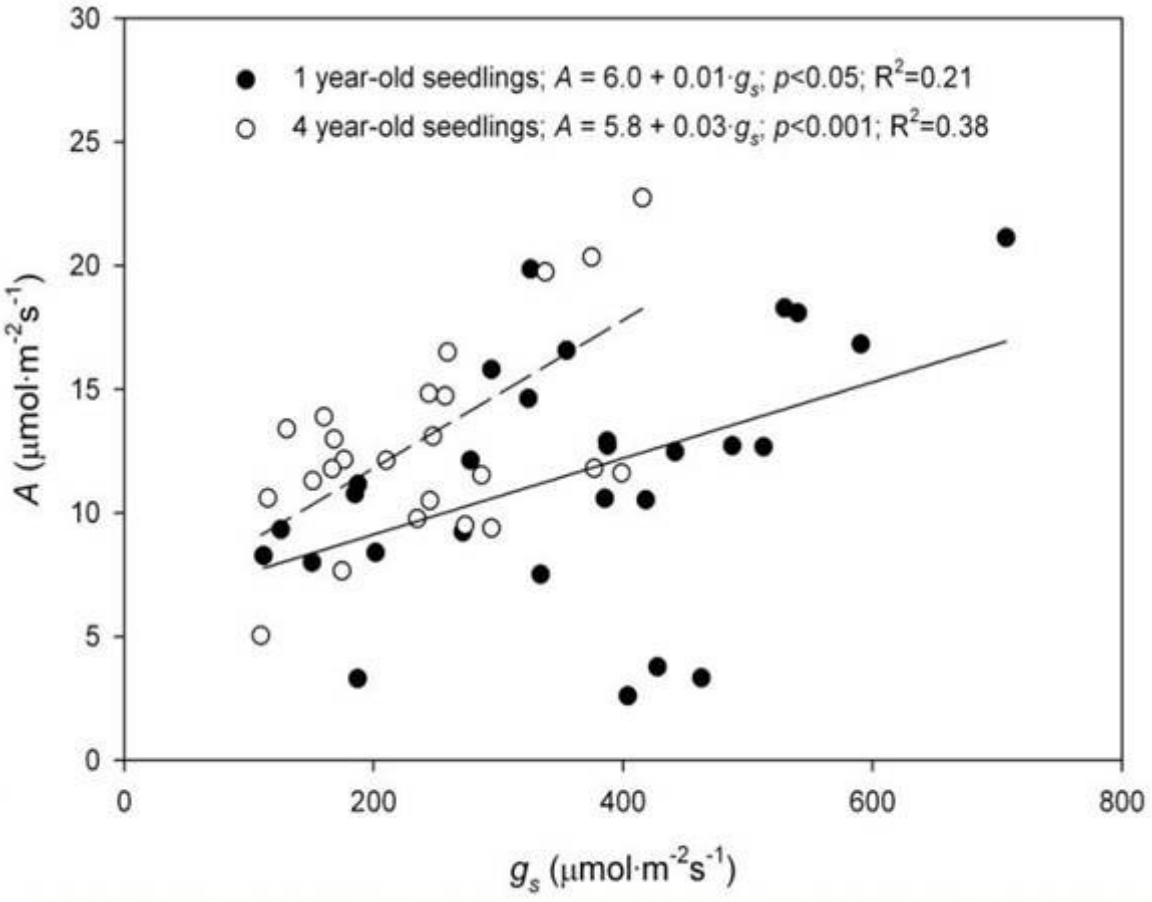


Predicting performance as a function of antecedent water status is a function of season

Predictability of shrub response to precipitation – water balance versus carbon assimilation

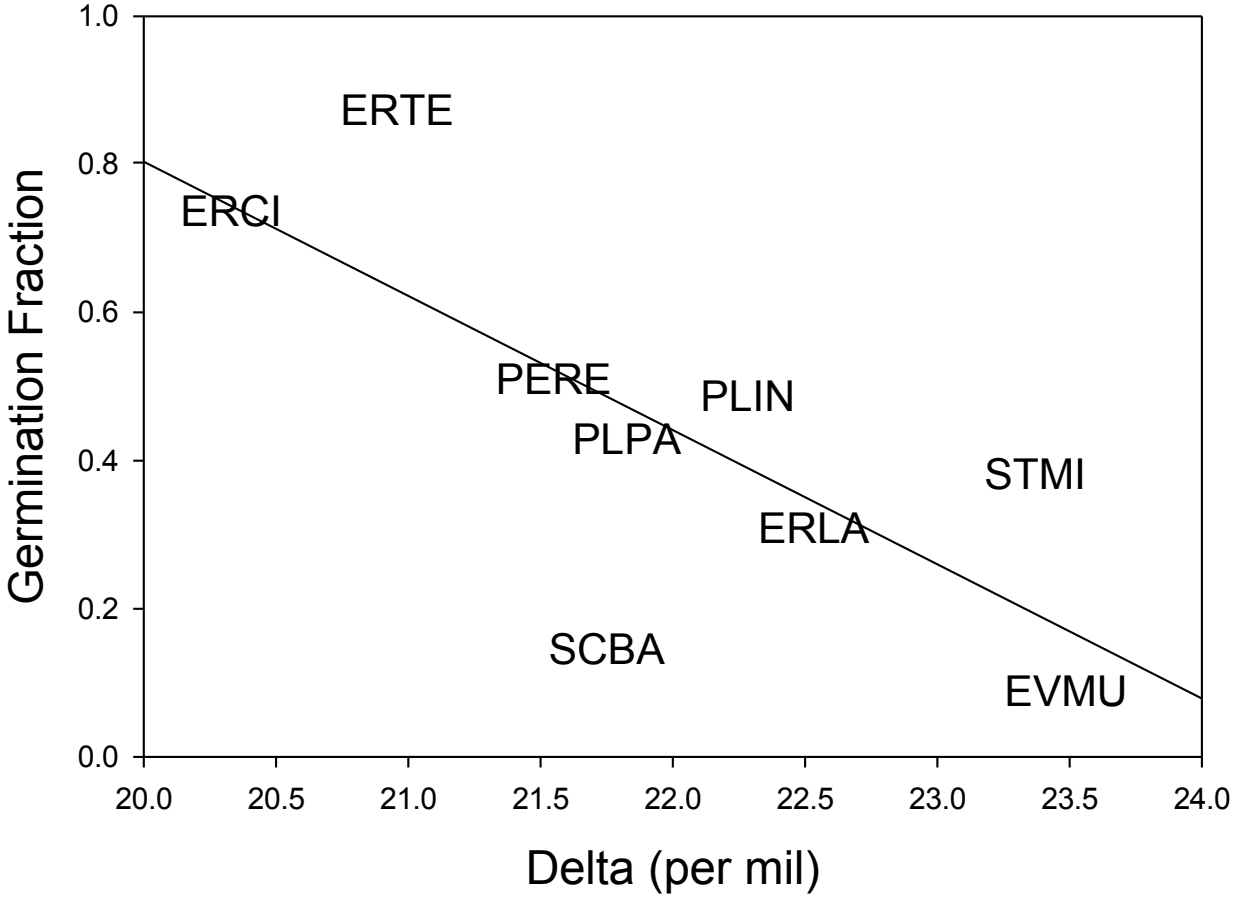


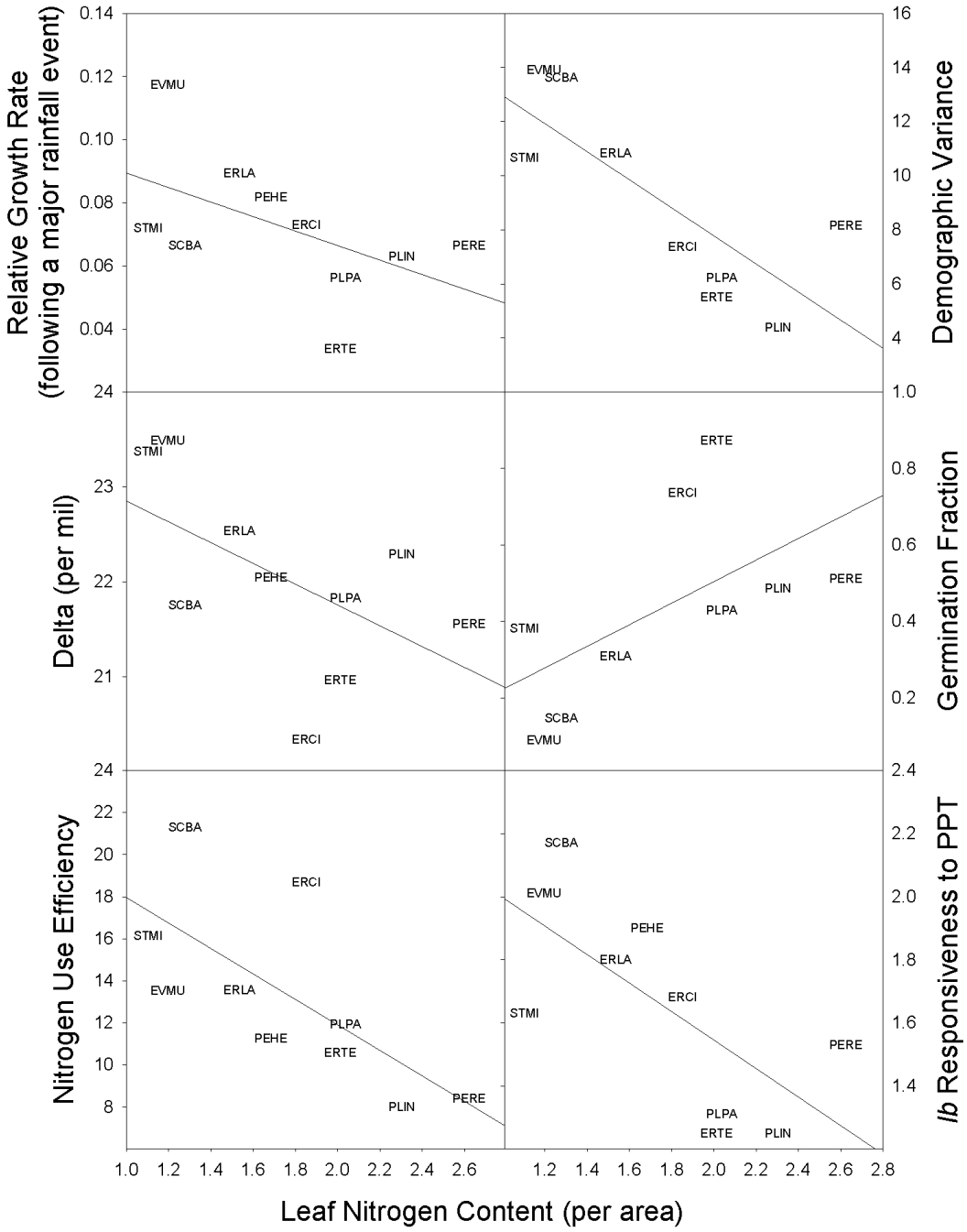
Greater water-use efficiency in older seedlings



Variable Rainfall, Populations and Communities

Inter-relate physiological syndromes and factors that influence demography



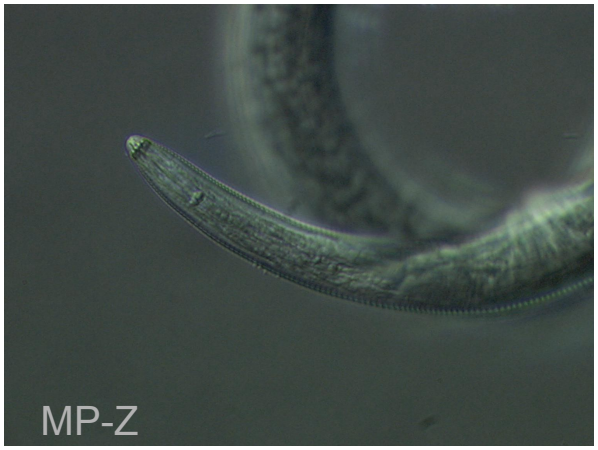


Species with high demographic variance have relatively high growth rates, low water-use efficiency, high nitrogen-use efficiency, and low germination fraction

Species with low demographic variance have relatively low growth rates, high water-use efficiency, low nitrogen-use efficiency, and high germination fraction

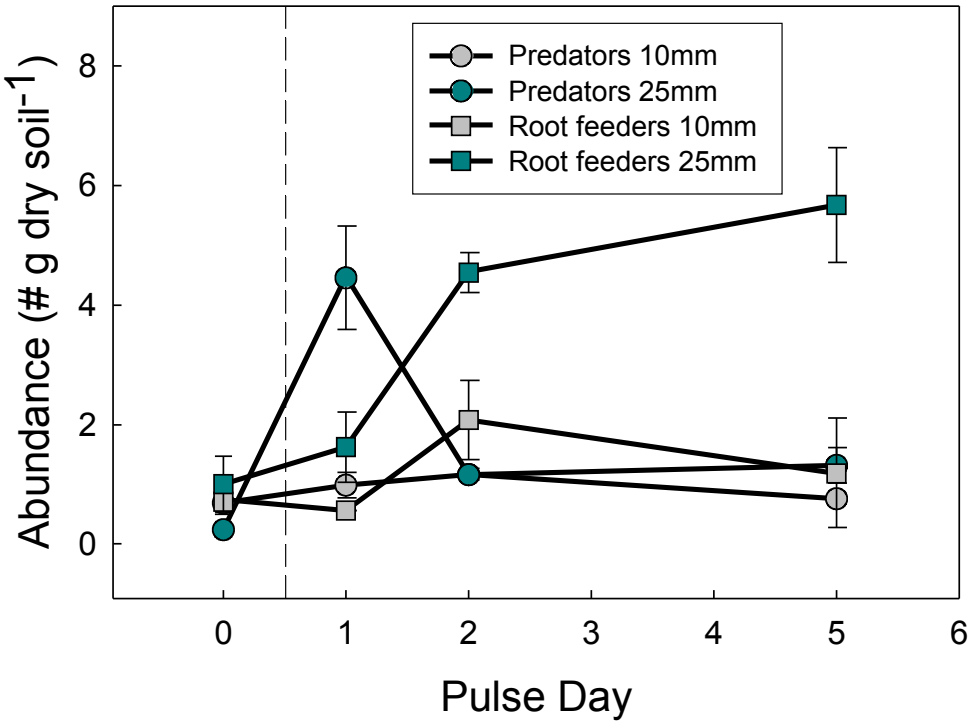
Why the relationship with leaf N?

Species interactions – predator / prey dynamics

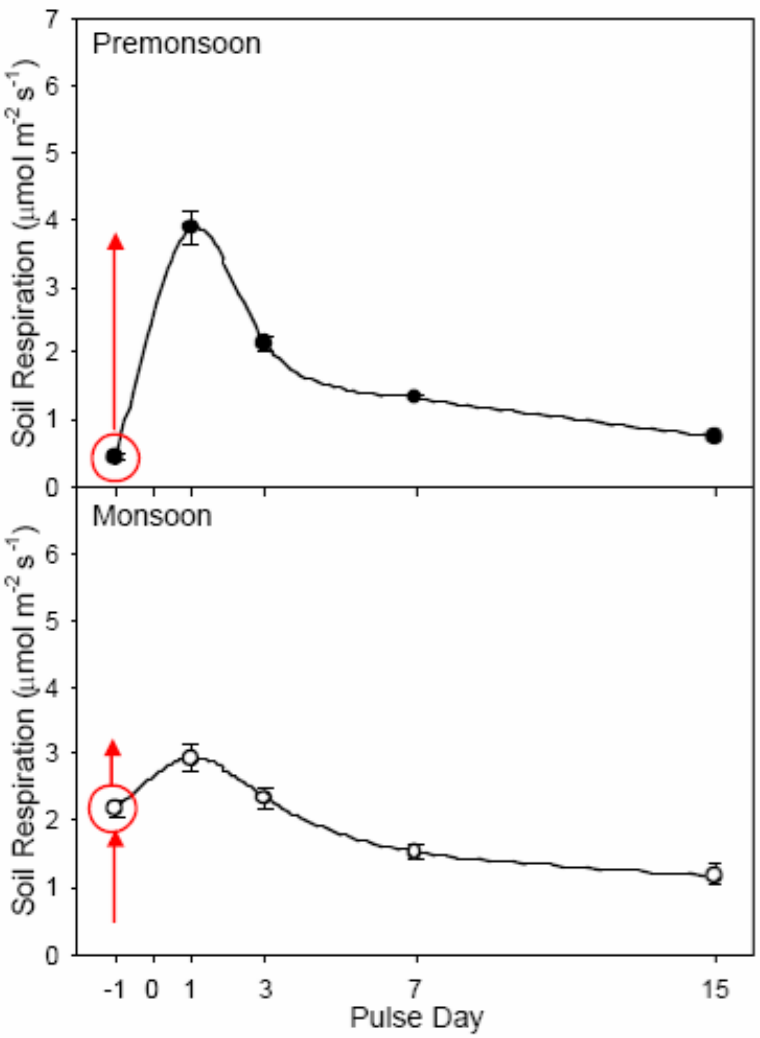


Root feeder functional group

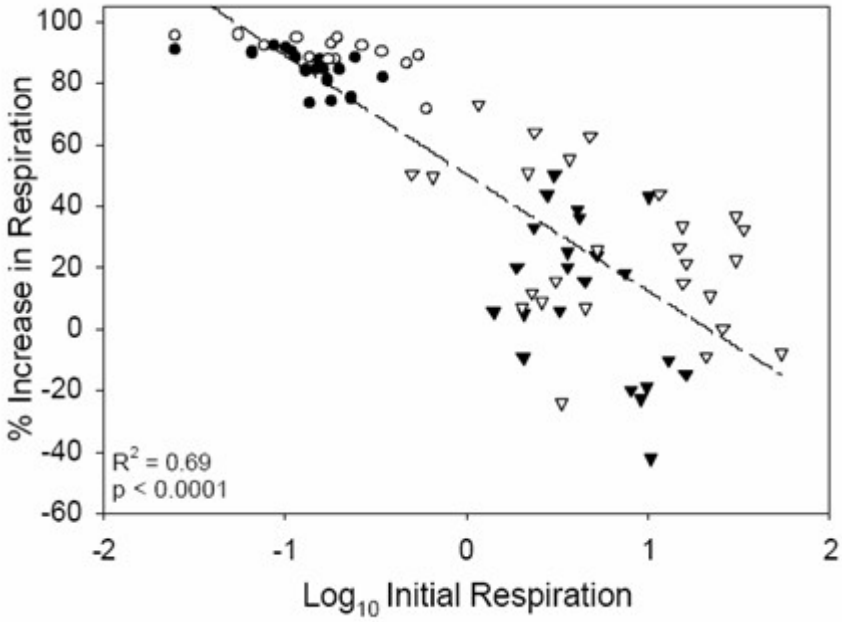
Predator functional group



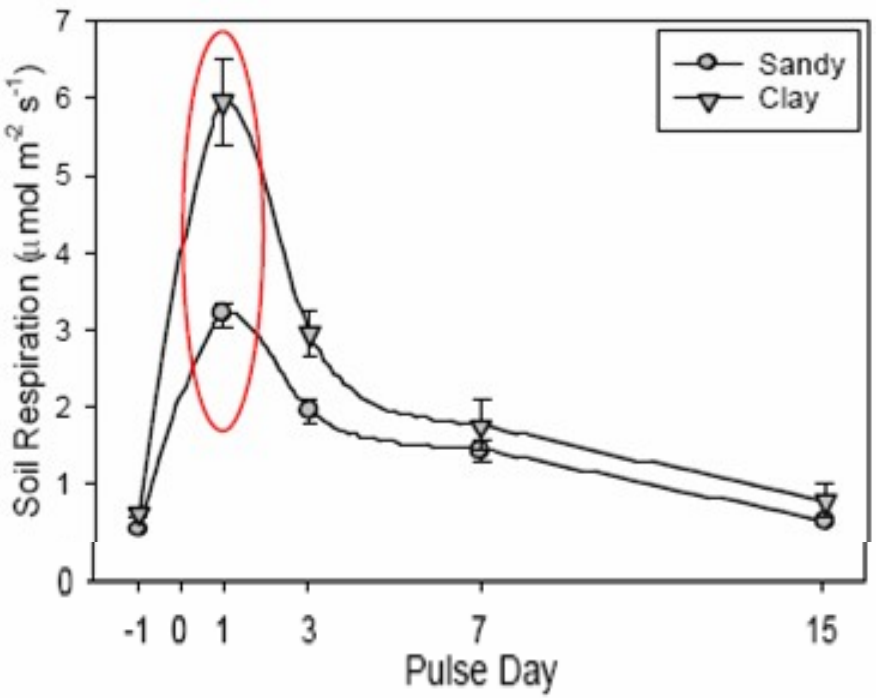
Restriction on biological time (associated with wet-dry cycles) influences the traditional expression of species interactions



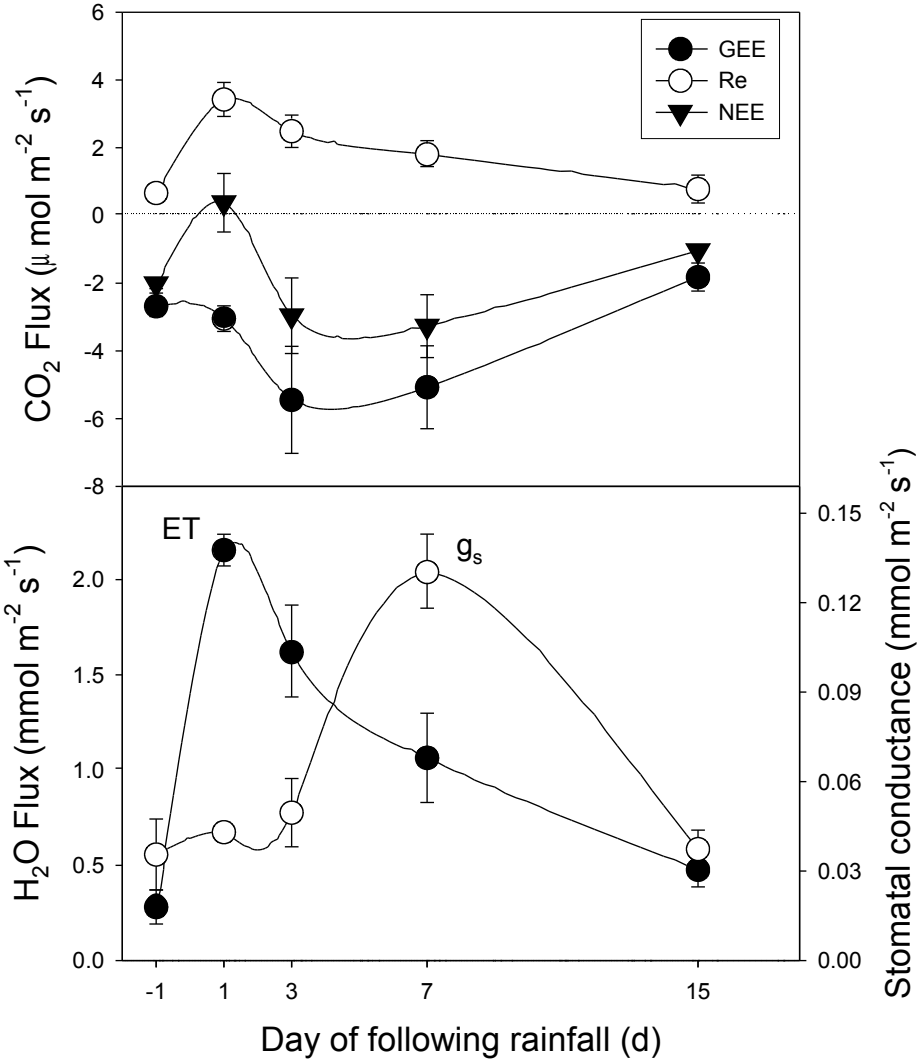
Many seasonal and treatment effects condense to the relationship between 'responsiveness' to precipitation and 'pre-condition'



Soil type has is a strong controller of soil respiration response to precipitation



My favorite question – is it the 'Inverse texture hypothesis' *or* the 'inverse, inverse texture hypothesis'?



Major contrast identified – soil versus plant responses in time.

Grassland → Shrubland

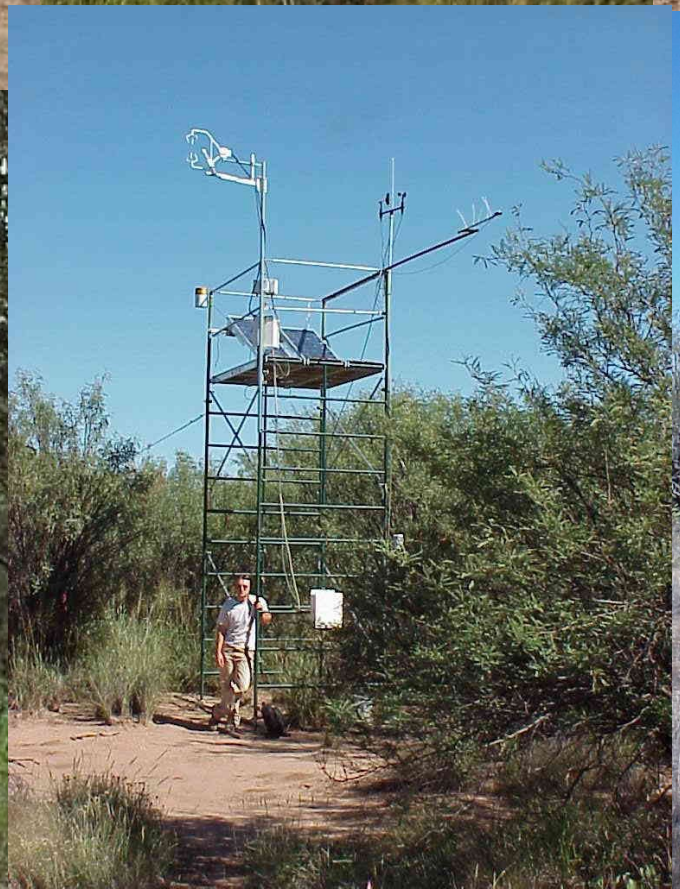
Grassland

Mesquite shrubland

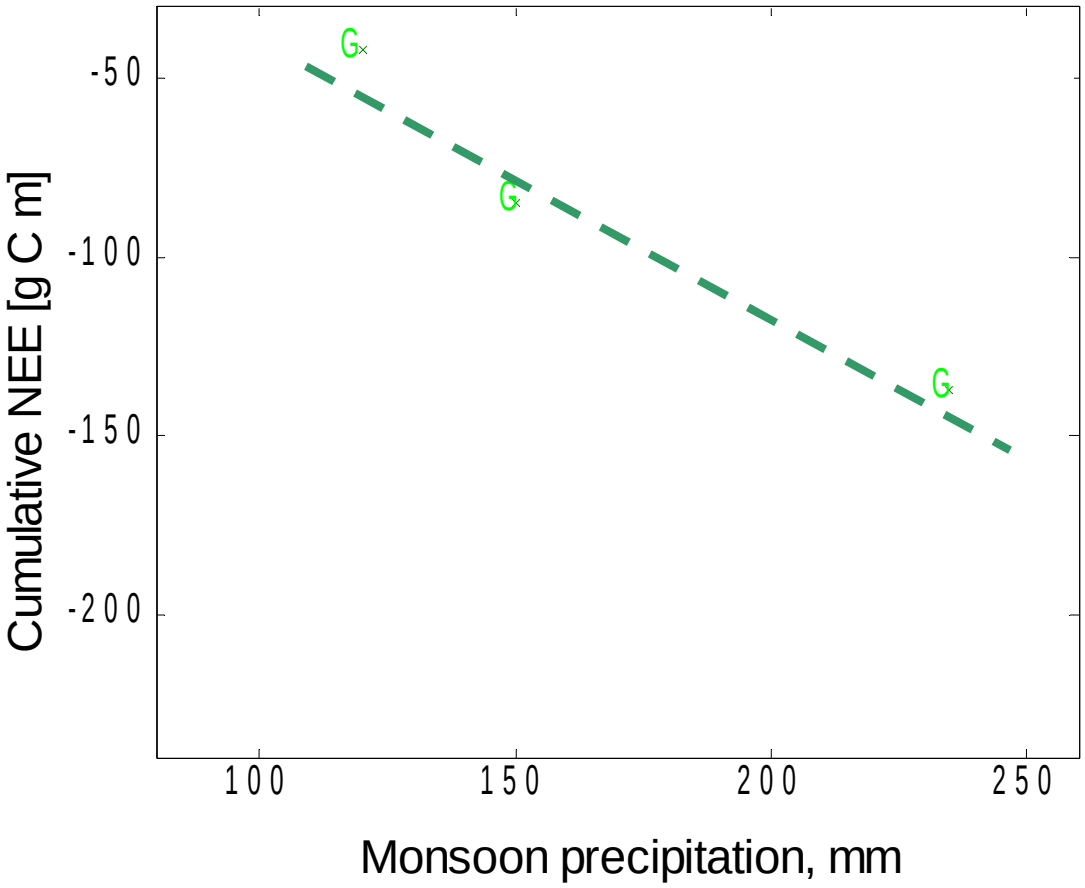
Creosote shrubland

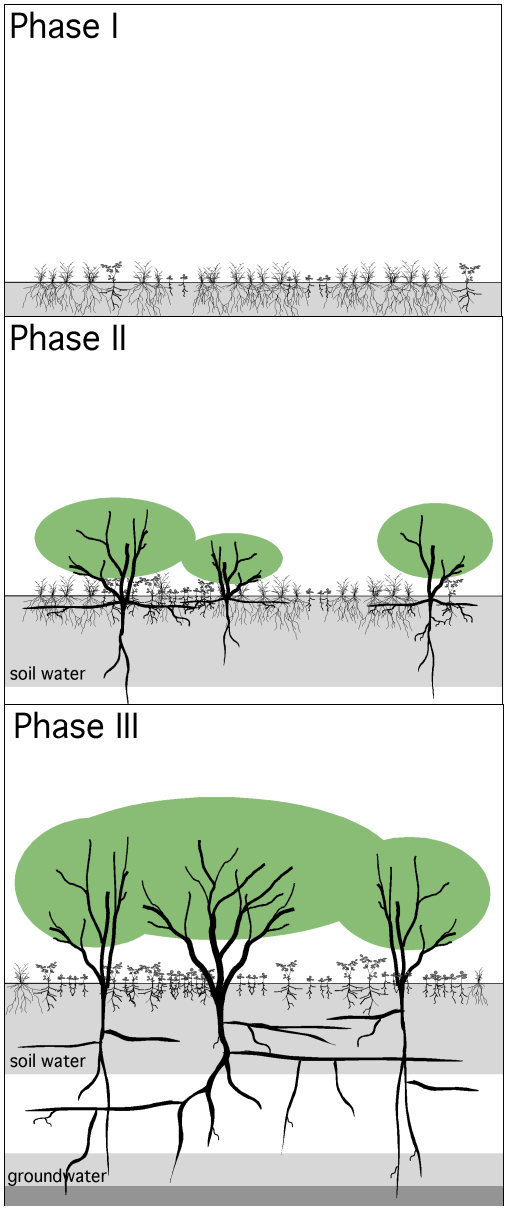






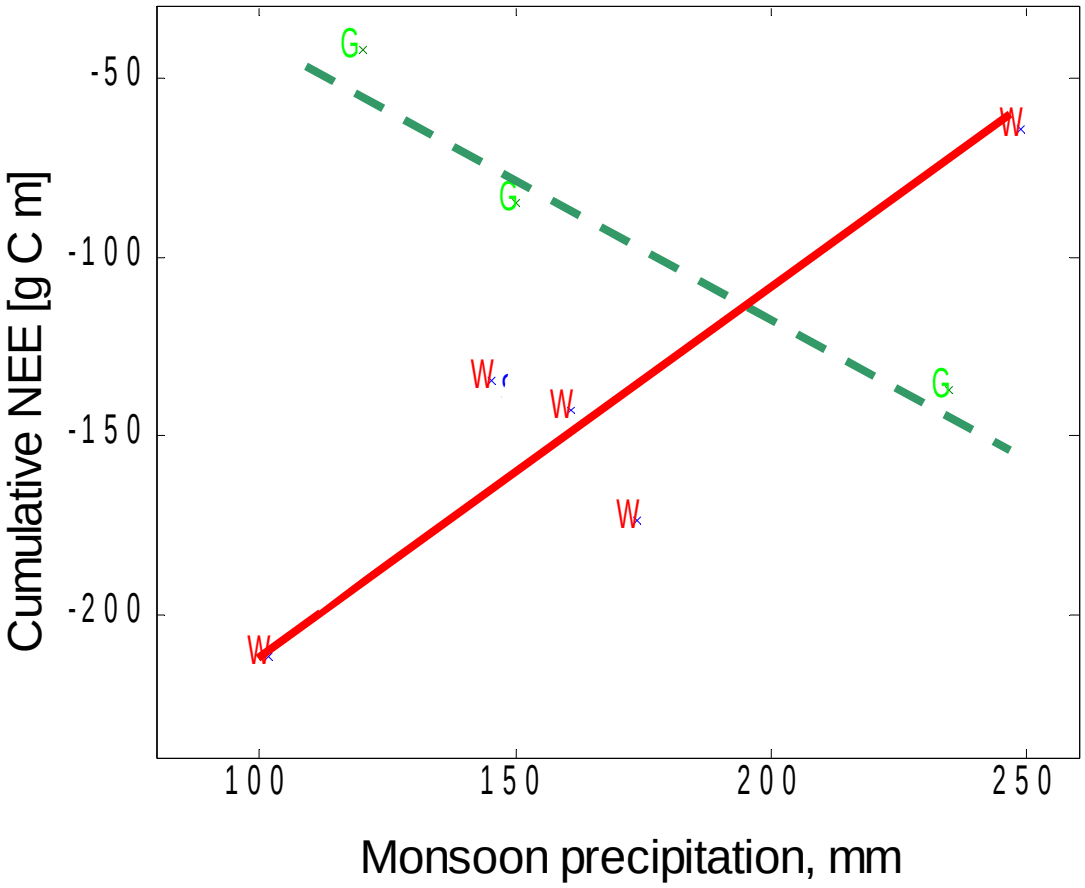

Growing season NEE sensitivity to precipitation

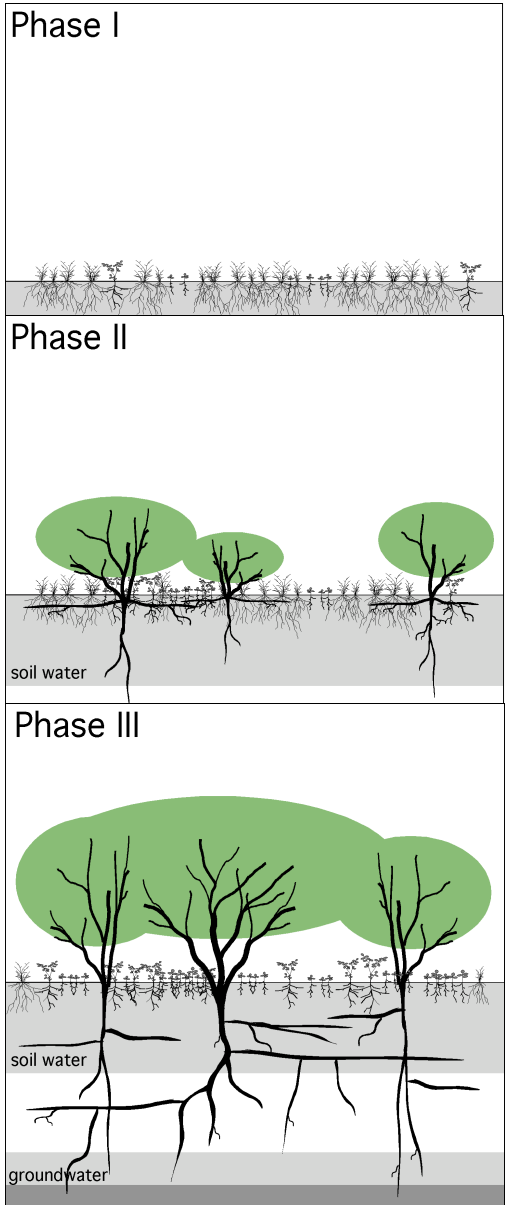




Typical of the pattern seen in many North American grasslands

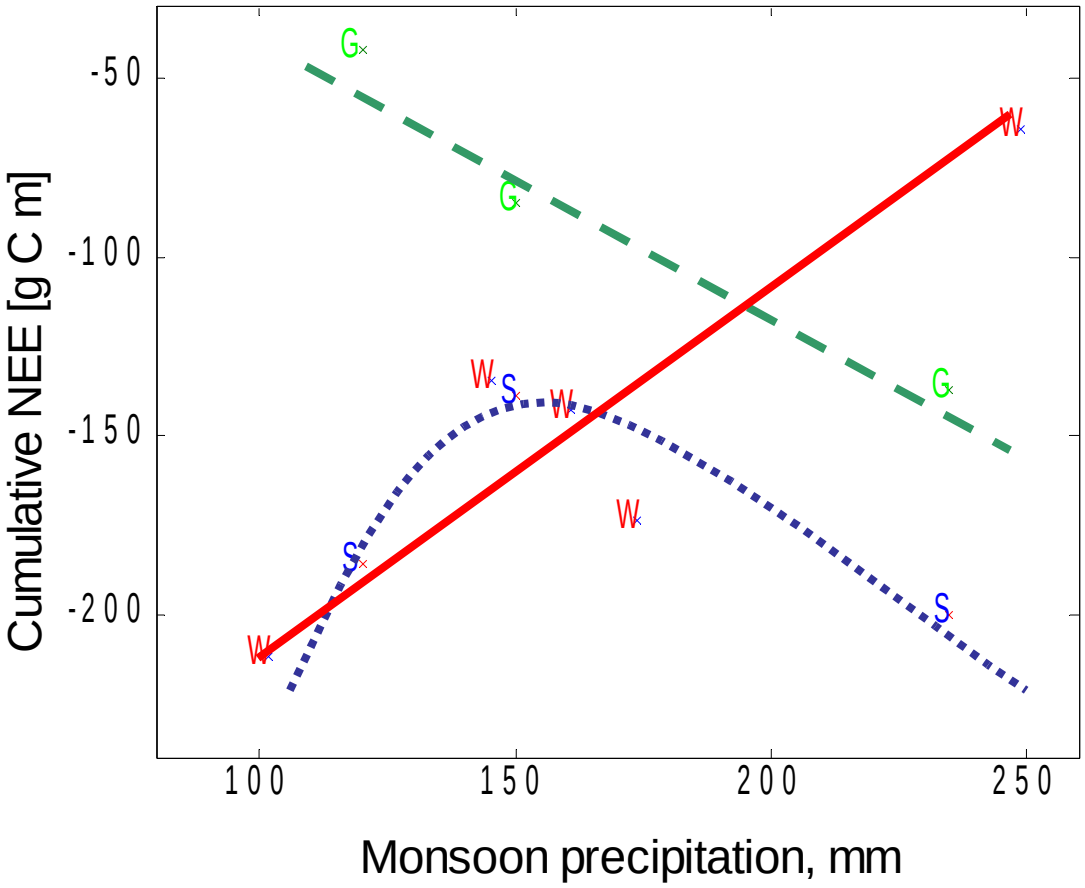
Growing season NEE sensitivity to precipitation

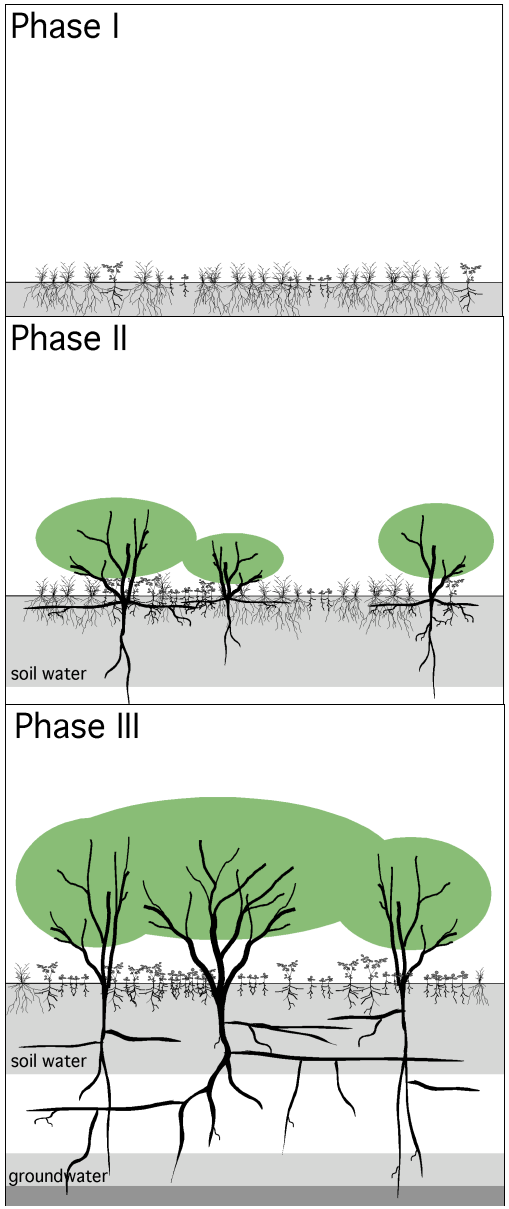




Grassland and Woodland have opposite responses to increases in growing season precipitation

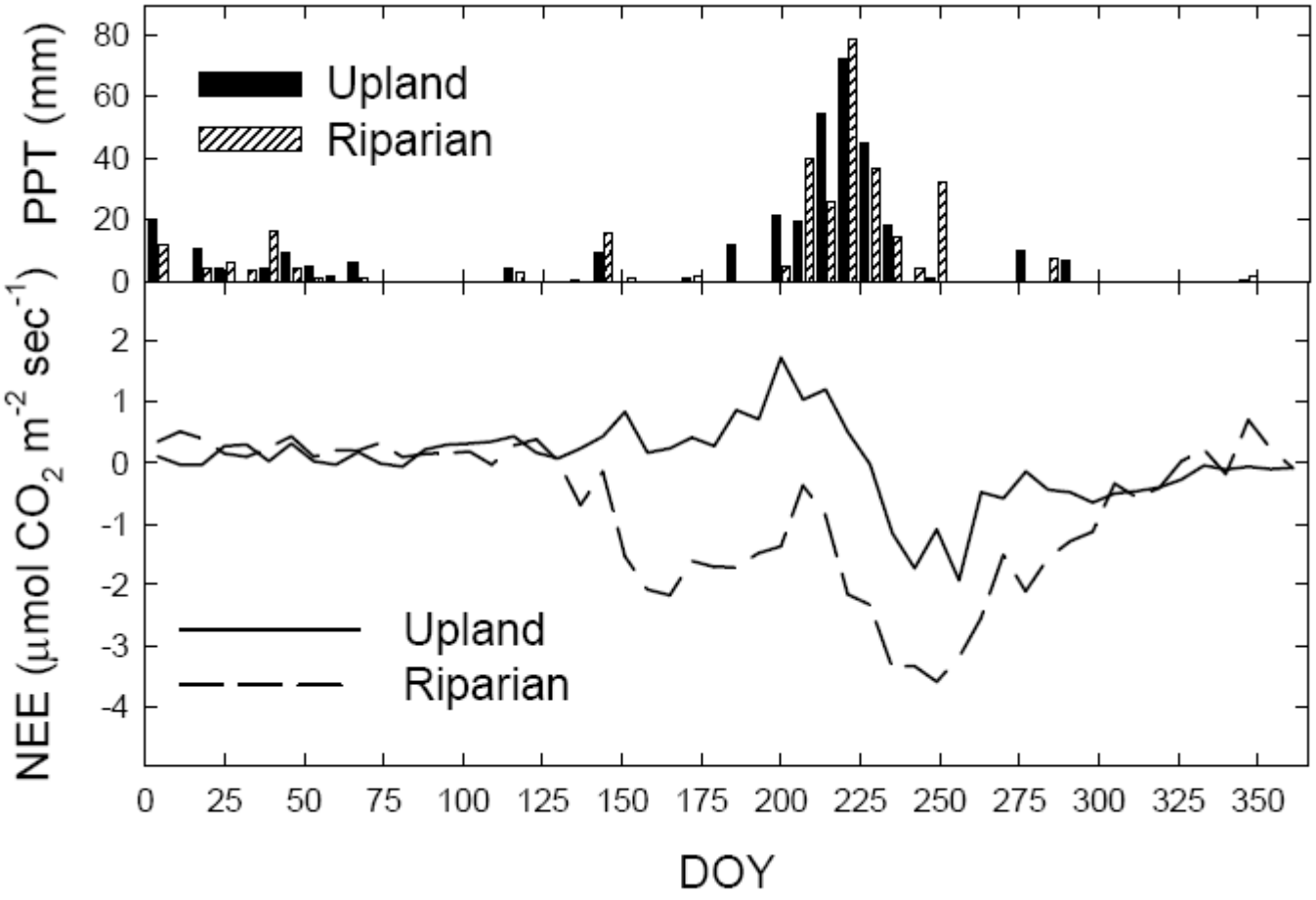
Growing season NEE sensitivity to precipitation

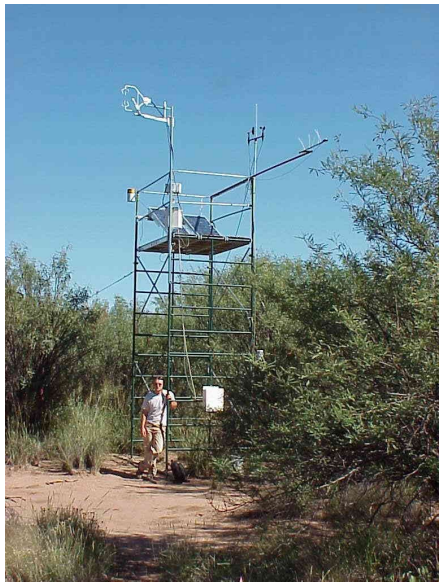




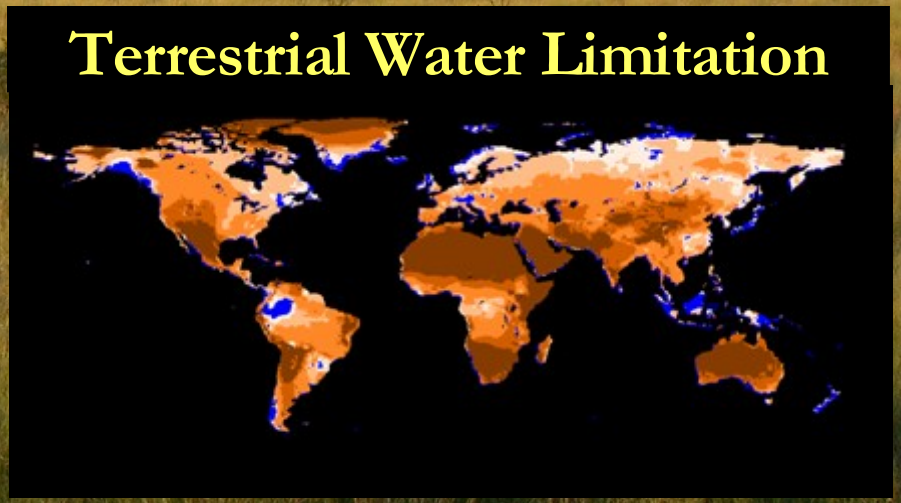
Non-linear response in the shrubland

Caption here about the contrast

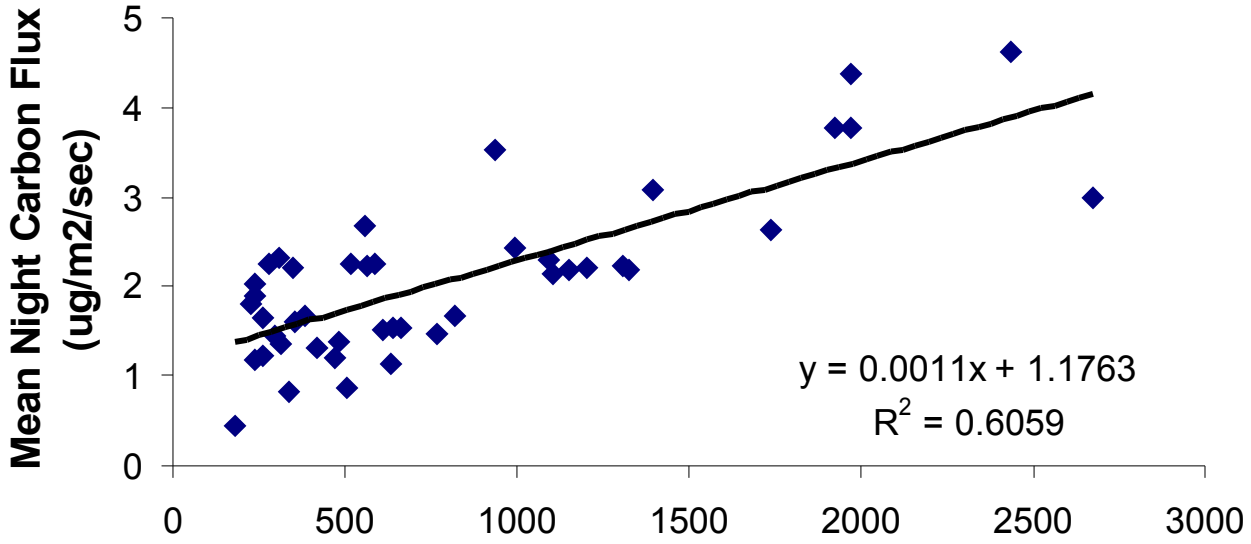


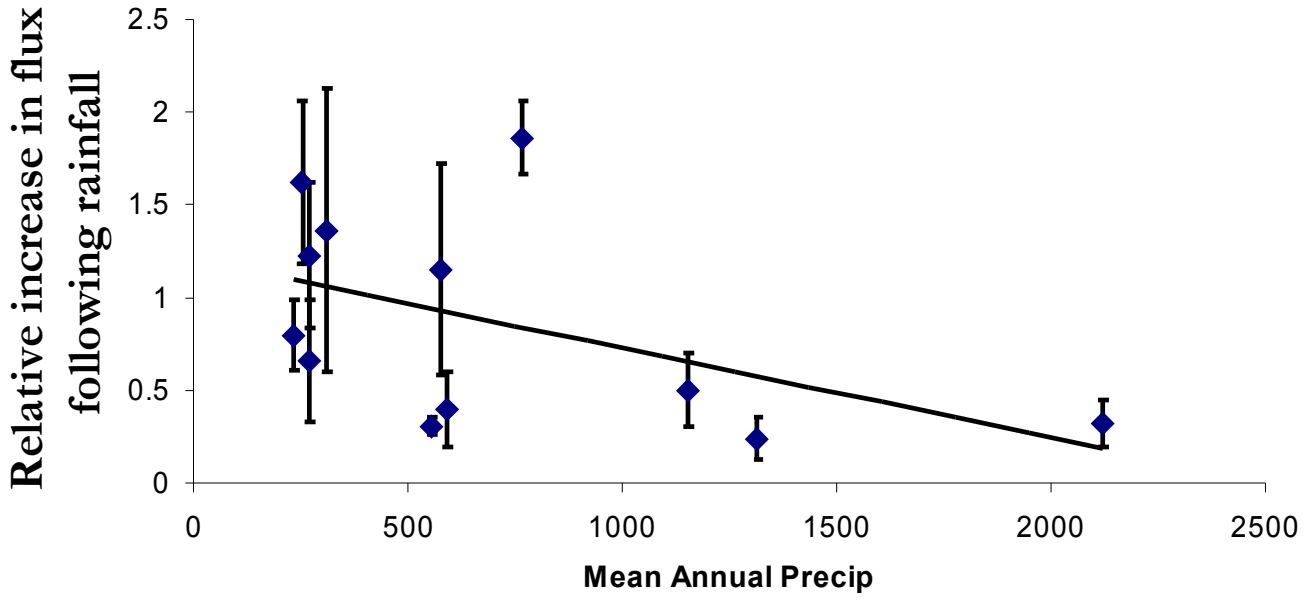


Are rainfall pulses only important in water limited regions?



CO_2 flux response to rainfall across many biomes





Acknowledgements

- Folks in the lab!
- Russell Scott – USDA-ARS Tucson
- Dave Williams – UWyom
- Jake Weltzin – UTenn
- Larry Venable - UofA
- NCEAS PrecipNet Working Group
- SAHRA, NSF, IALC, USDA, University of Arizona

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