The feedback of Arizona Grassland to Longer Seasonal Droughts and its Implication for Dryland Carbon Cycling: Insights from Model-Experiment Integration
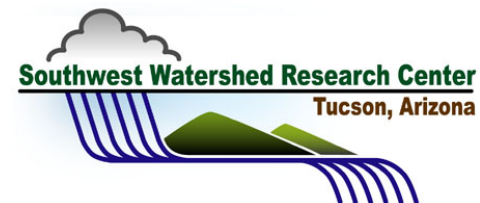
Yang Song

Assistant Professor

Contributors: Tianyi Hu, Patrick J Neri, Joel A. Biederman, William K Smith
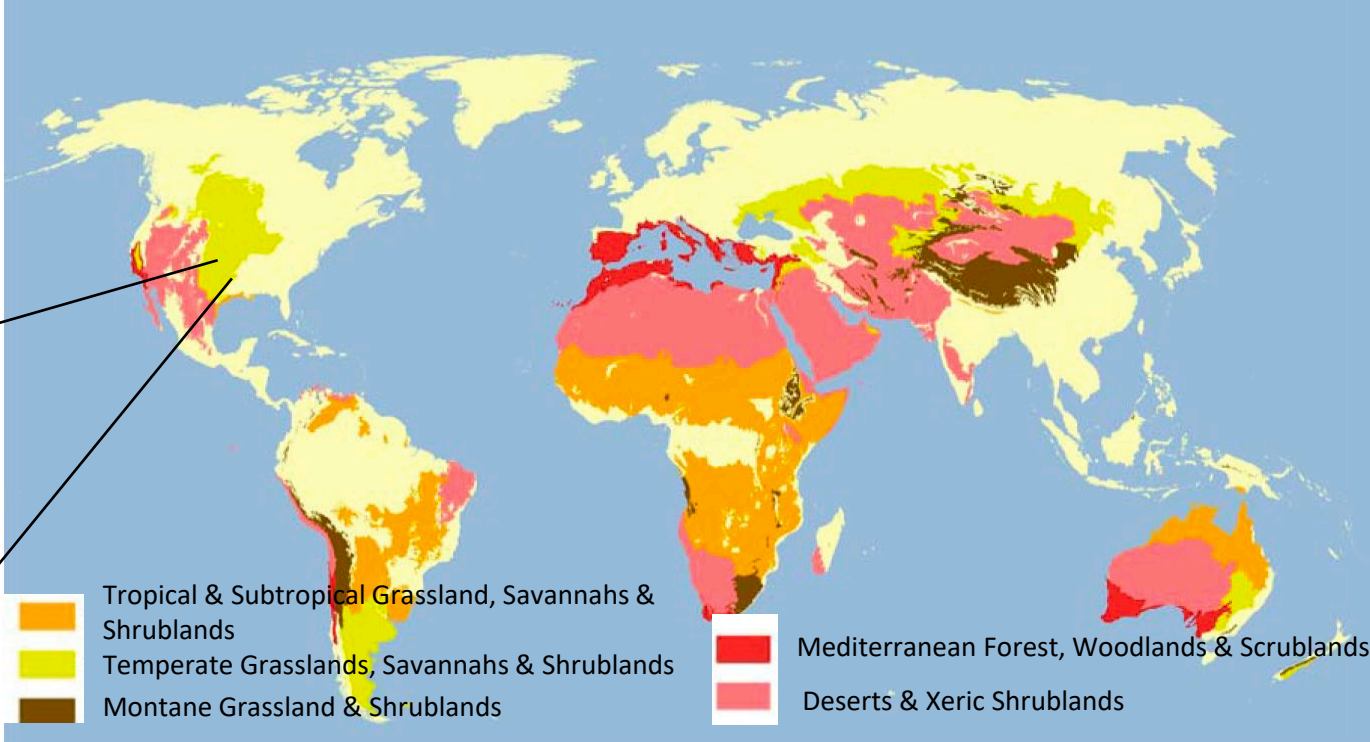
Email: chopinsong@arizona.edu

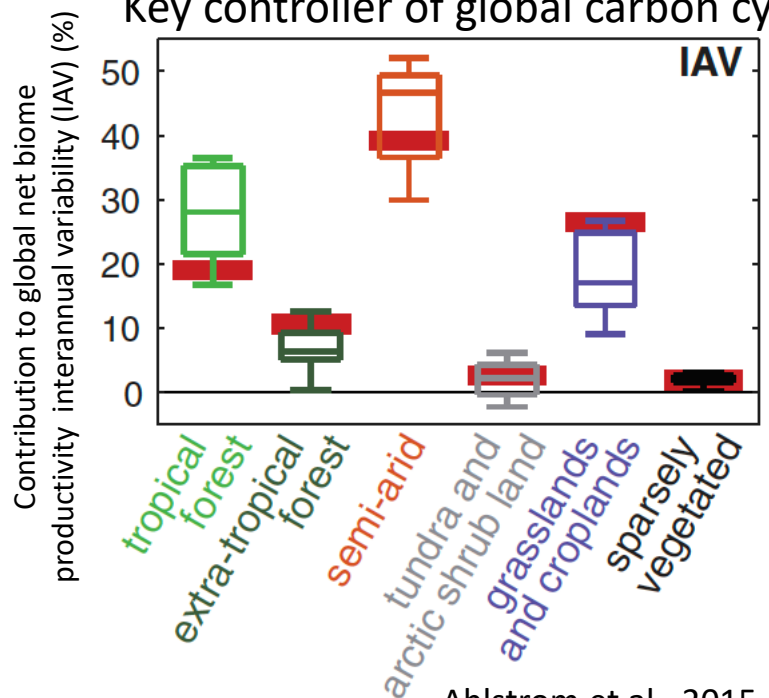Sep 30, 2021

SONG BIO-ESM LAB

TRIF/WEES AIR Resilience Grants

ENVIRONMENT

Southwest Watershed Research Center
Tucson, Arizona

Research domain: dryland ecosystem

Arizona grassland

Tropical & Subtropical Grassland, Savannahs & Shrublands

Temperate Grasslands, Savannahs & Shrublands

Montane Grassland & Shrublands

Mediterranean Forest, Woodlands & Scrublands

Deserts & Xeric Shrublands

Key controller of global carbon cycle

IAV

Contribution to global net biome productivity interannual variability (IAV) (%)

tropical forest
extra-tropical forest
semi-arid
tundra and arctic shrub land
grasslands and croplands
sparsely vegetated

Ahlstrom et al., 2015, Science

Key ecosystem services

Forage & grazing   Soil conservation   C fixation   Biodiversity

# Developing a prediction tool to assess the climate resilience of Arizona grassland

Fewer, larger precipitation events & longer dry intervals between rainfall

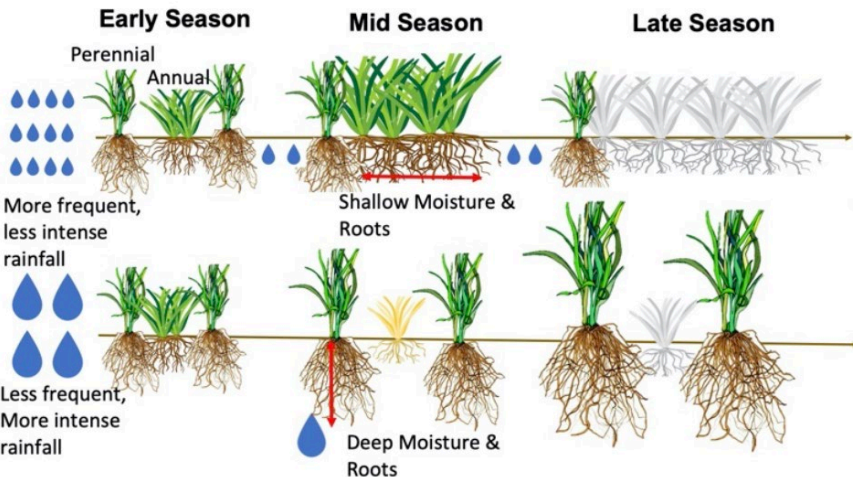Zhang et al., 2021

Research Questions
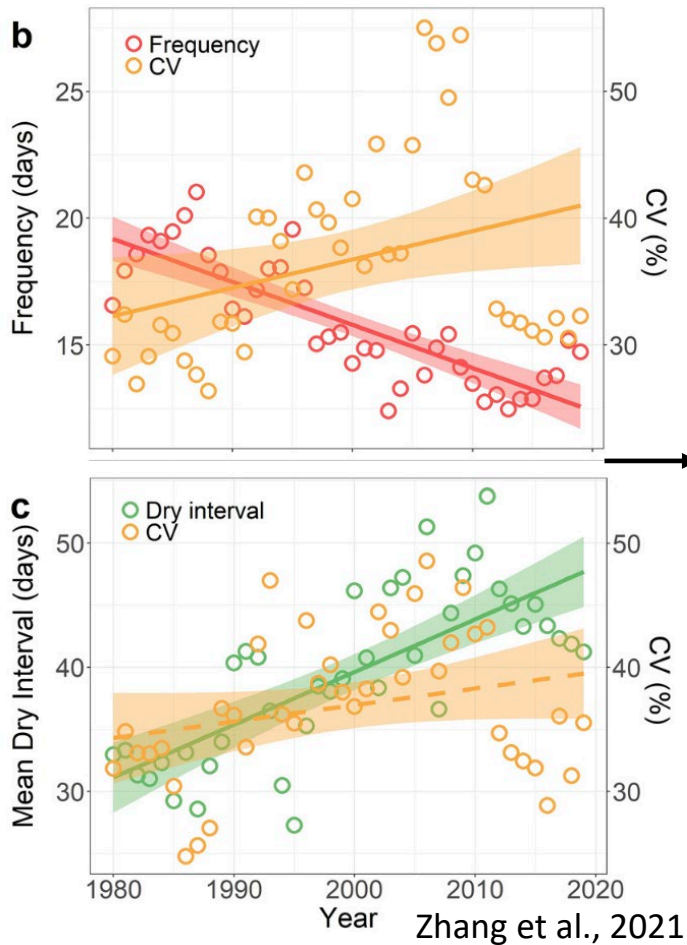
- ✓ *How does Arizona grassland acclimate to change in the Northern American Monsoon ?*

- ✓ *How does climate acclimation of Arizona grassland affect its ecosystem function ?*

- ✓ *How does the climate resilience of Arizona grassland vary over the time ?*

Precipitation manipulation experiment in the Santa Rita Experimental Range
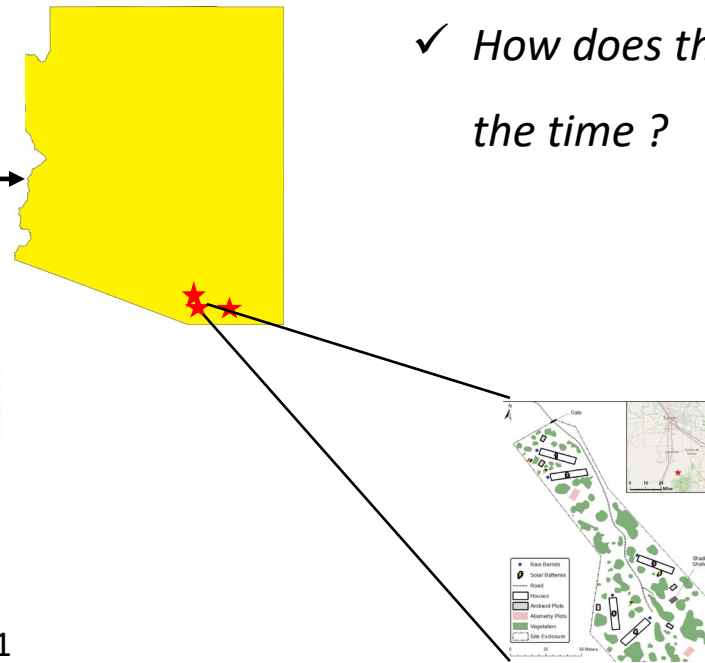
Research Method: Multi-scale data-mechanism-model approach

Incorporation of mechanisms into the model

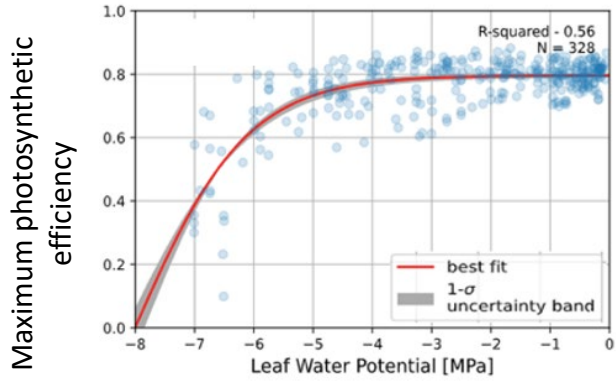Parameterizing climate acclimation mechanism

RainMan precipitation manipulation experiment in the Santa Rita Experimental Range

Experiment-informed change in grassland productivity, phenology, plant structure, and community change
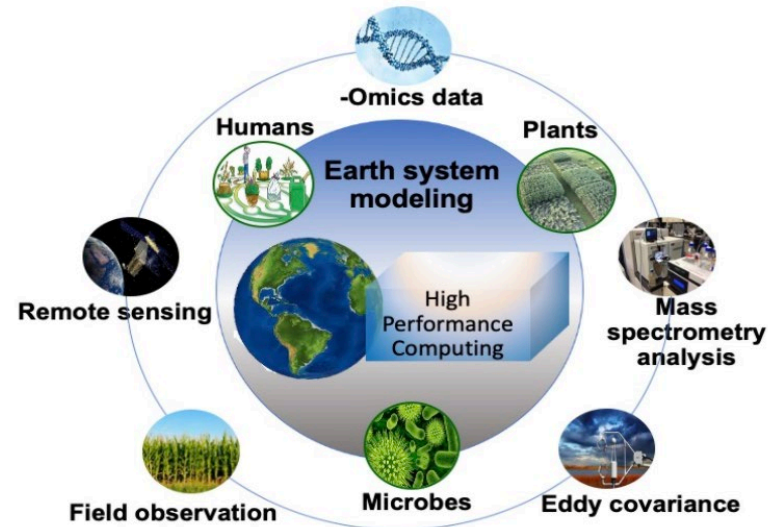
Solar induced chlorophyll fluorescence informed photosynthetic acclimation to water potential

Neri et al. (in prep)

Represent semiarid grass functional types with distinct drought tolerance and functional traits in the Community Land Model (CLM)

Key findings

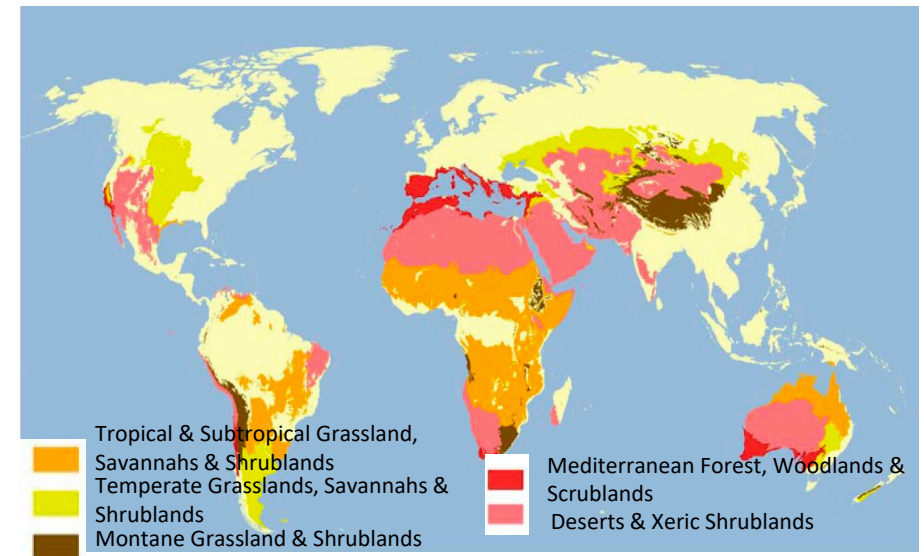Hu et al. (in prep)
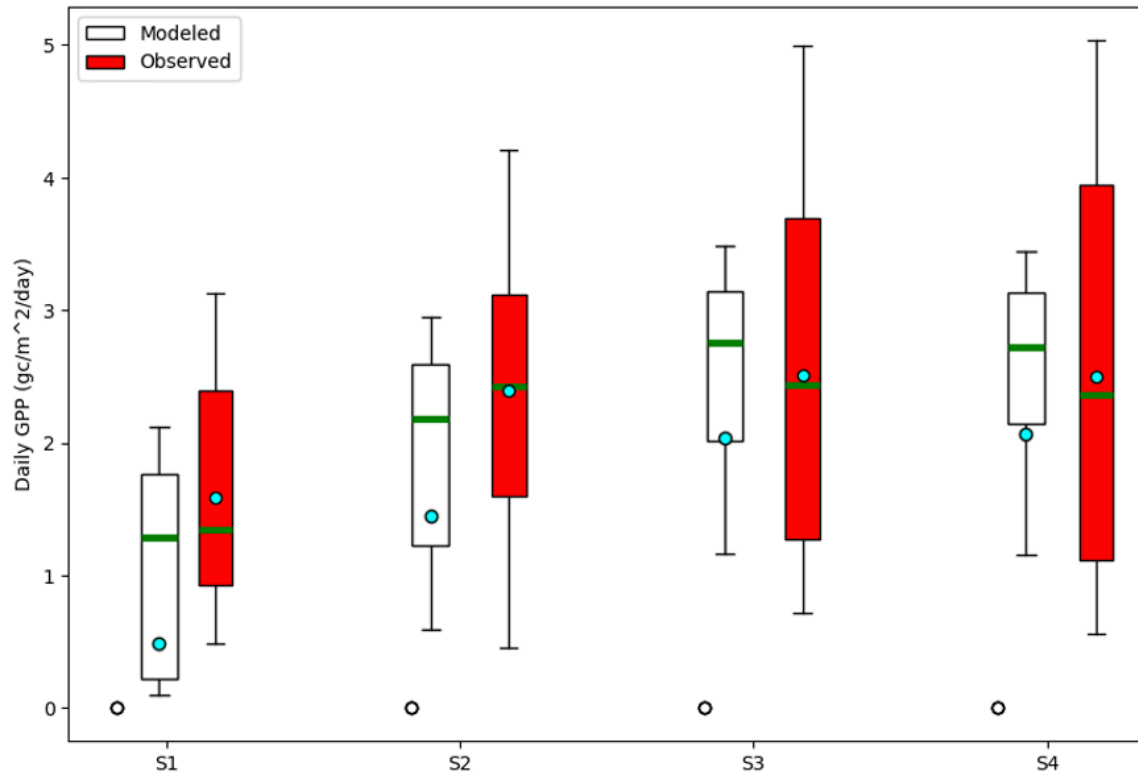
Fewer, larger rainfall events
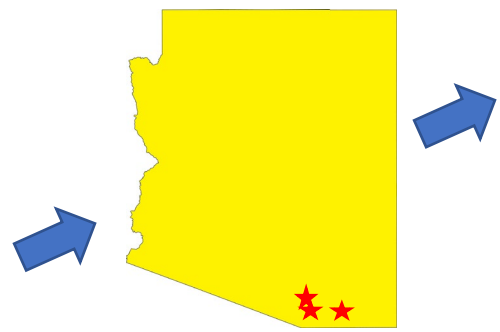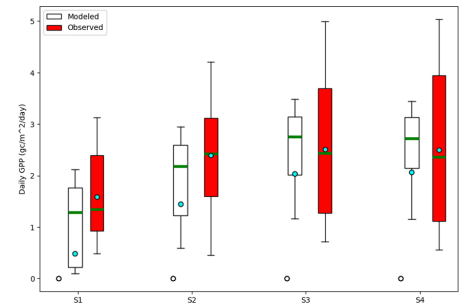-**Promoted the growth of perennial C4 grasses** with deeper roots and stronger tolerance to lower soil water potential.

-**Increased the gross primary productivity (GPP)** of Arizona grassland, but decreased biodiversity during the first year of precipitation manipulation.

Representing distinct drought acclimation of perennial C4 grasses enables to **capture sensitivity of GPP to change in the Northern American Monsoon**
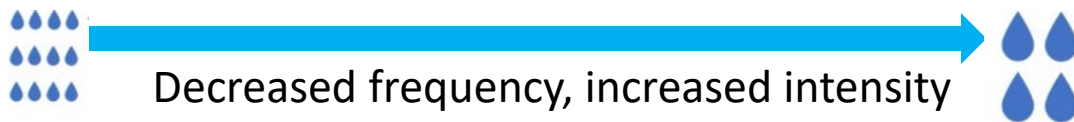
Going-on research and potential international collaboration
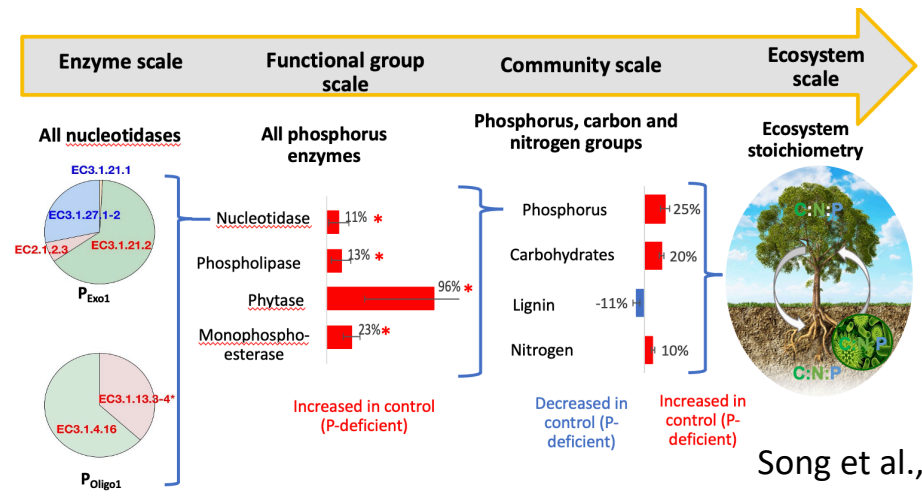

Assess the climate resilience of global dryland

Tropical & Subtropical Grassland, Savannahs & Shrublands
Temperate Grasslands, Savannahs & Shrublands
Montane Grassland & Shrublands
Mediterranean Forest, Woodlands & Scrublands
Deserts & Xeric Shrublands

Harness the power of SIF data to predict the " Evolution" of climate resilience of dryland

"Evolution" of $\phi_{PSIImax}$ -Temperature feedback

Time exposed to a specific temperature level

<Two days   < Two weeks   > Two weeks   Long-term
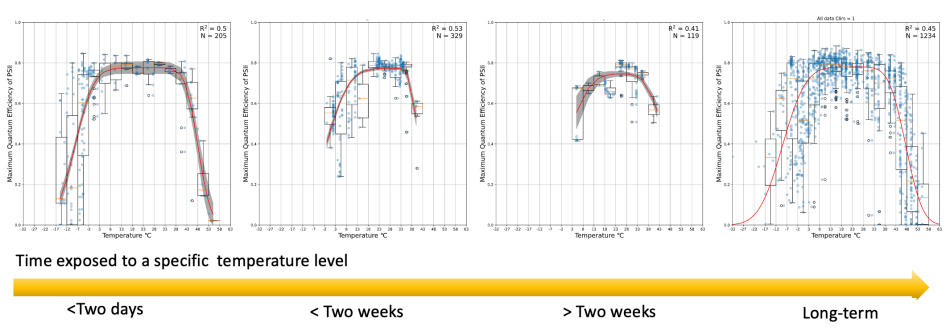
Neri et al. (in prep)

Harness the power of genomic data to predict climate acclimation of microbial community and its role on dryland ecosystem function

Enzyme scale   Functional group scale   Community scale   Ecosystem scale

All nucleotidases   All phosphorus enzymes   Phosphorus, carbon and nitrogen groups   Ecosystem stoichiometry

Nucleotidase   11% *
Phospholipase   13% *
Phytase   96% *
Monophospho-esterase   23% *

Phosphorus   25%
Carbohydrates   20%
Lignin   -11%
Nitrogen   10%

Increased in control (P-deficient)

Decreased in control (P-deficient)

Increased in control (P-deficient)

Song et al., 2021