Understanding Ecological Responses To Climate Variability Across a Big State

or

Why Does Everything in Texas Have to be Big!

Dr. John Zak, Department of Biological Sciences, TTU

Associate Dean for Research, College of Arts and Sciences,

Lead TTU –PI with the South Central Climate Science Center Consortium

Talk Outline

Section 1: History Does Repeat Itself!

Section 2: Large Scale Patterns for TX: What do we Know?

Section 3: What does Climate Variability Look Like in the SCR

Section 4: How has Climate Changed in the SCR?

Section 5: How the Small Scale Can Influence Everything!!!

Section 6: No Chicken Little Here!

History Repeats Itself

- **Section 1**

The Variability of Climate and Implications to Society

"In the 1880's cattleman began to arrive from the drought stricken plains of west Texas and Oklahoma to graze their Longhorns on the last of the open range in the Apache Natl. Forest."
From Also Leopold His Life and Work by Curt Meine

The Athabasca Oils Sands- 1976

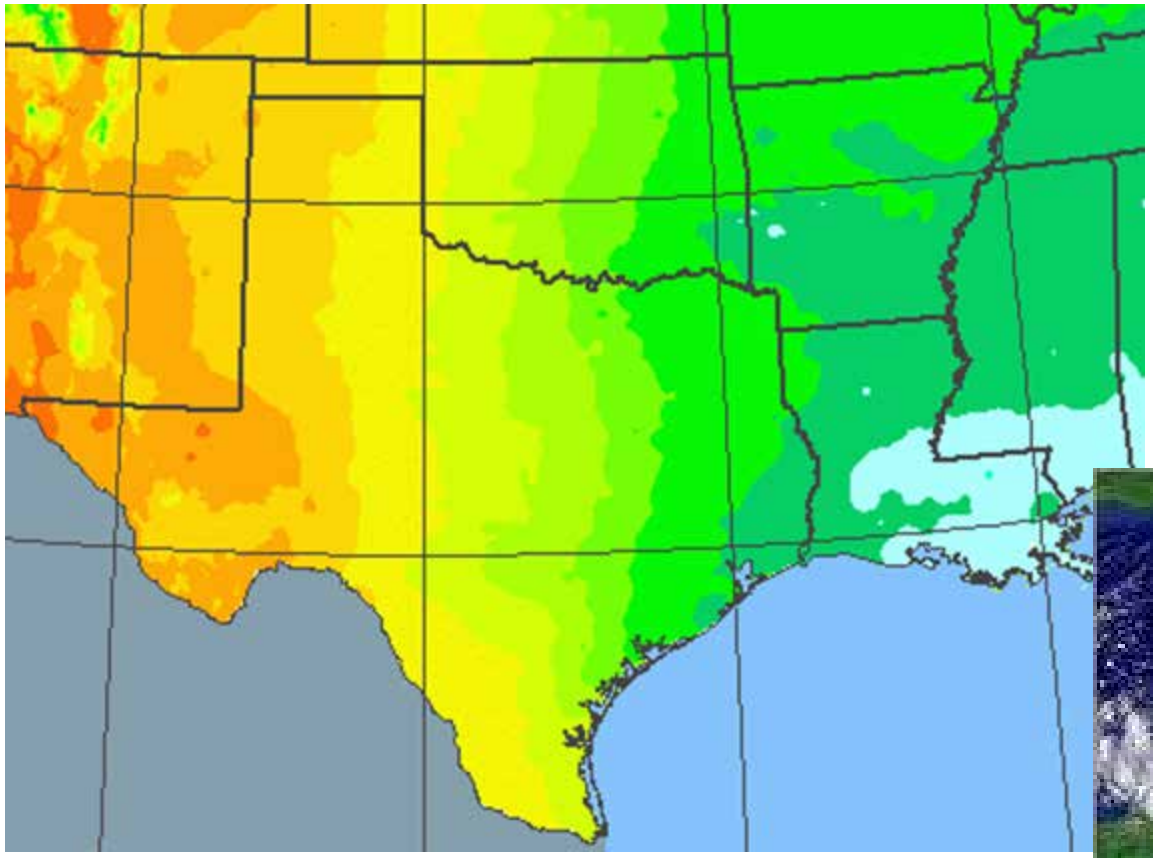
The Keystone XL Pipeline Route

Large Scale Patterns for TX: What do We Know?

- **Section 2**

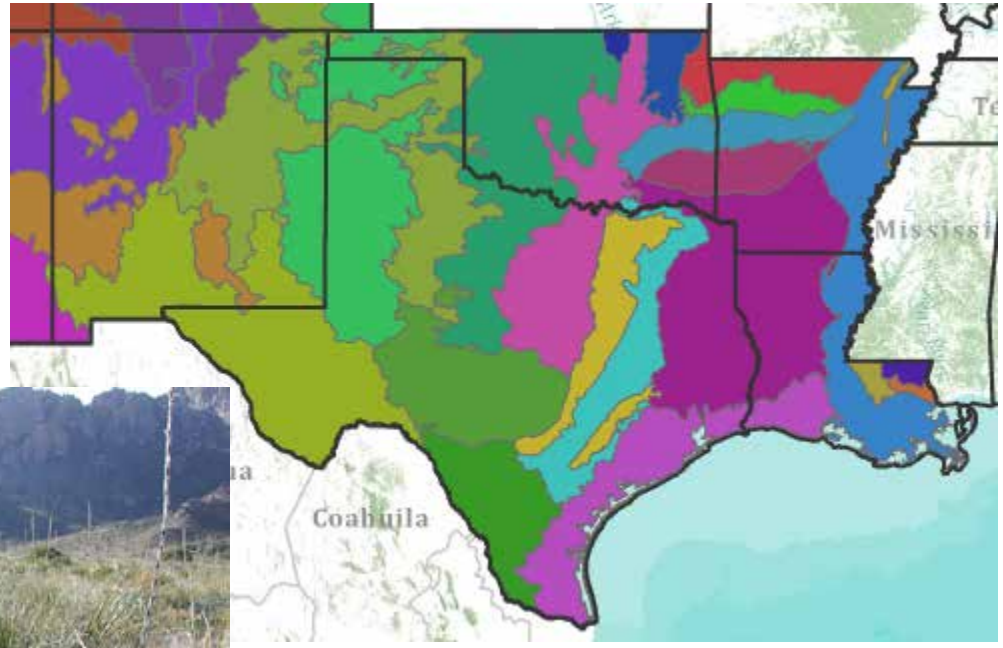
South Central Region -Average Precipitation

- 15 to 150 cm range

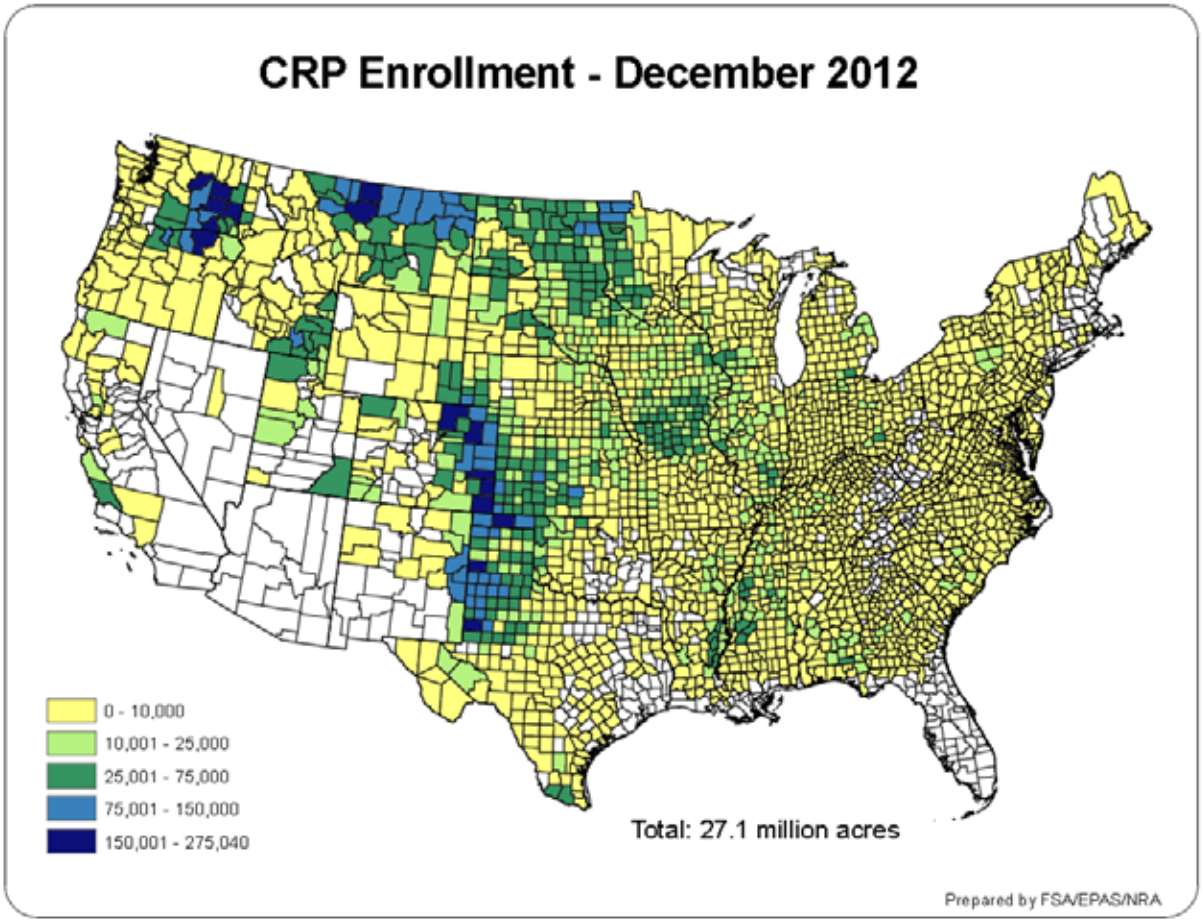


Landscape Patterns of the South Central Region(CSR)

- 20 ecoregions (related to precipitation and temperatures)



CRP Enrollment in TX and Impacts on Biodiversity and Watersheds



2010 Census Data for SCR

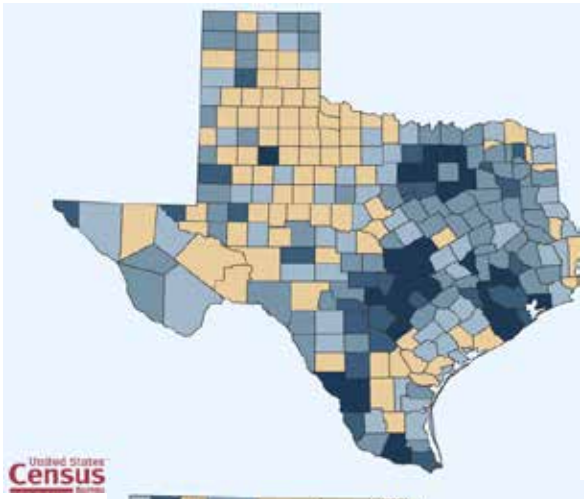
Texas = 25,145,561

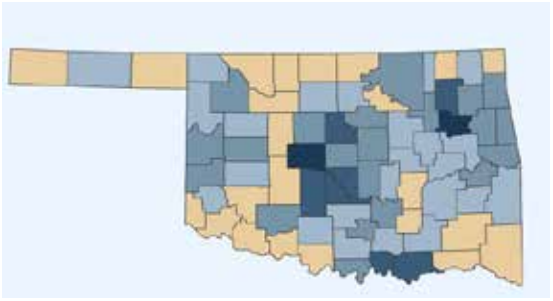
Oklahoma = 3,751,351

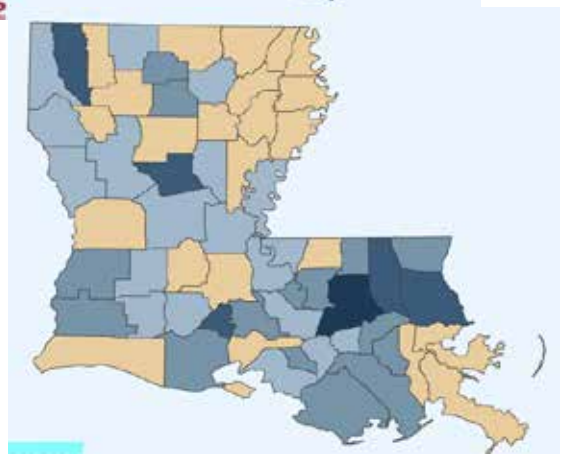
Louisiana = 4,533,372

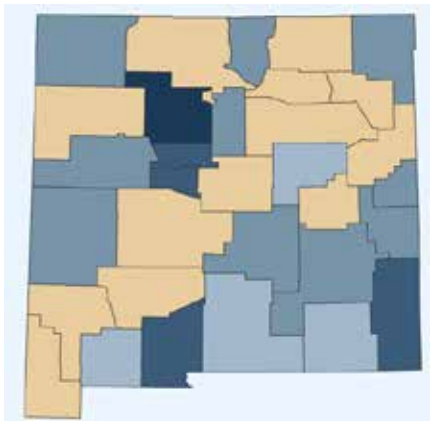
New Mexico = 2,059,179

35,489,463 (11.5%)



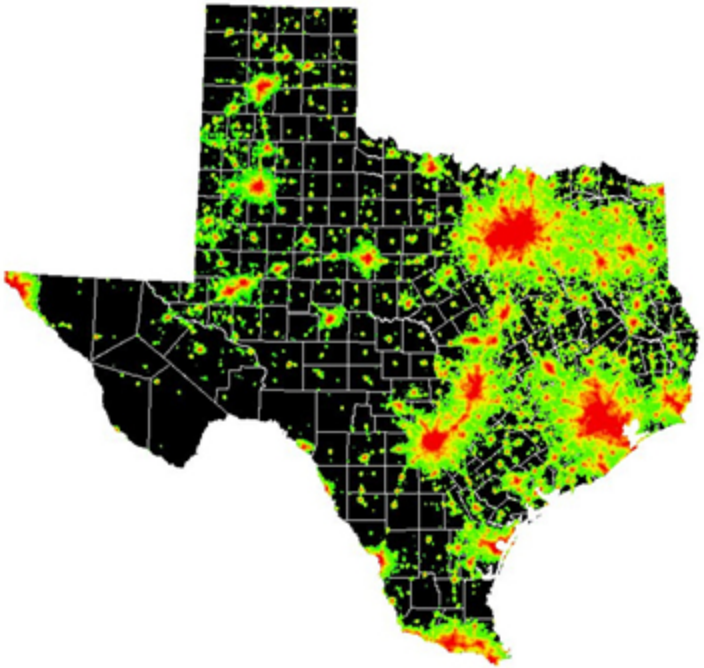




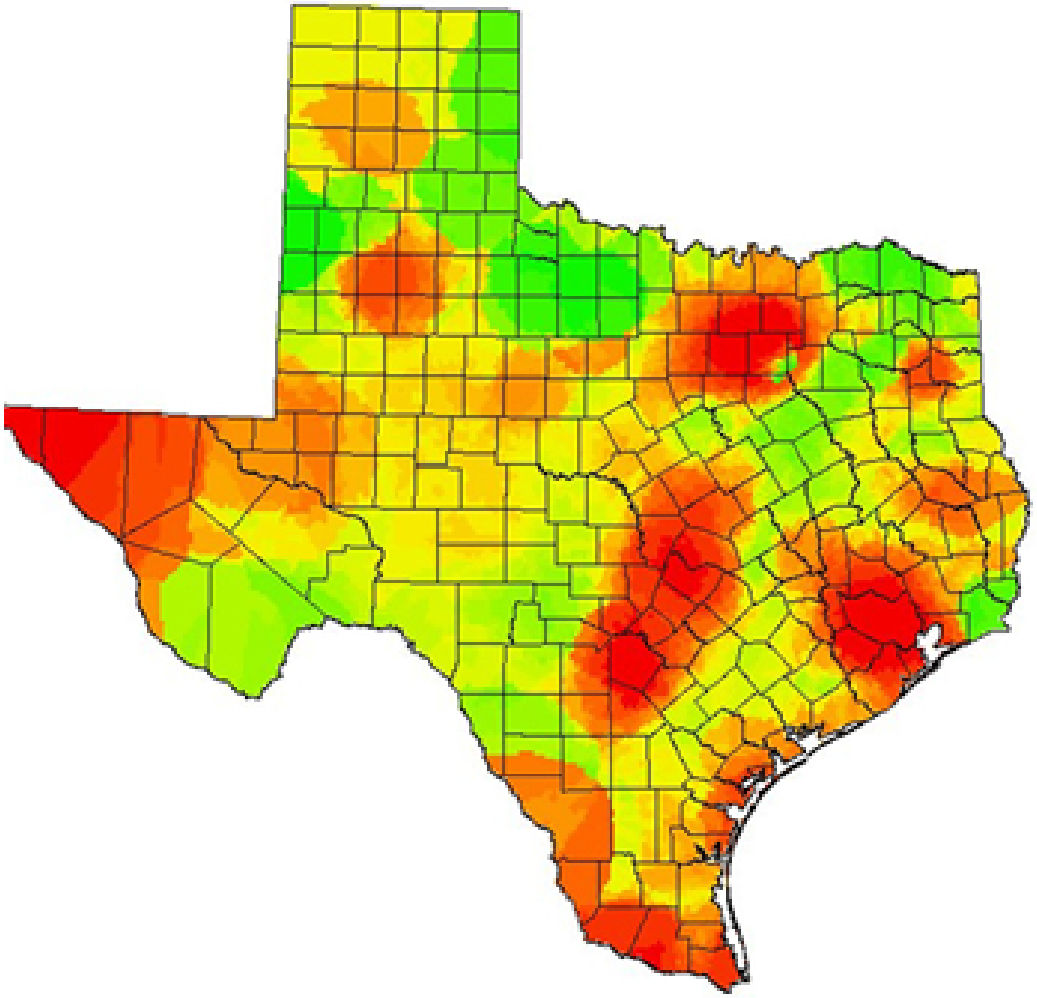


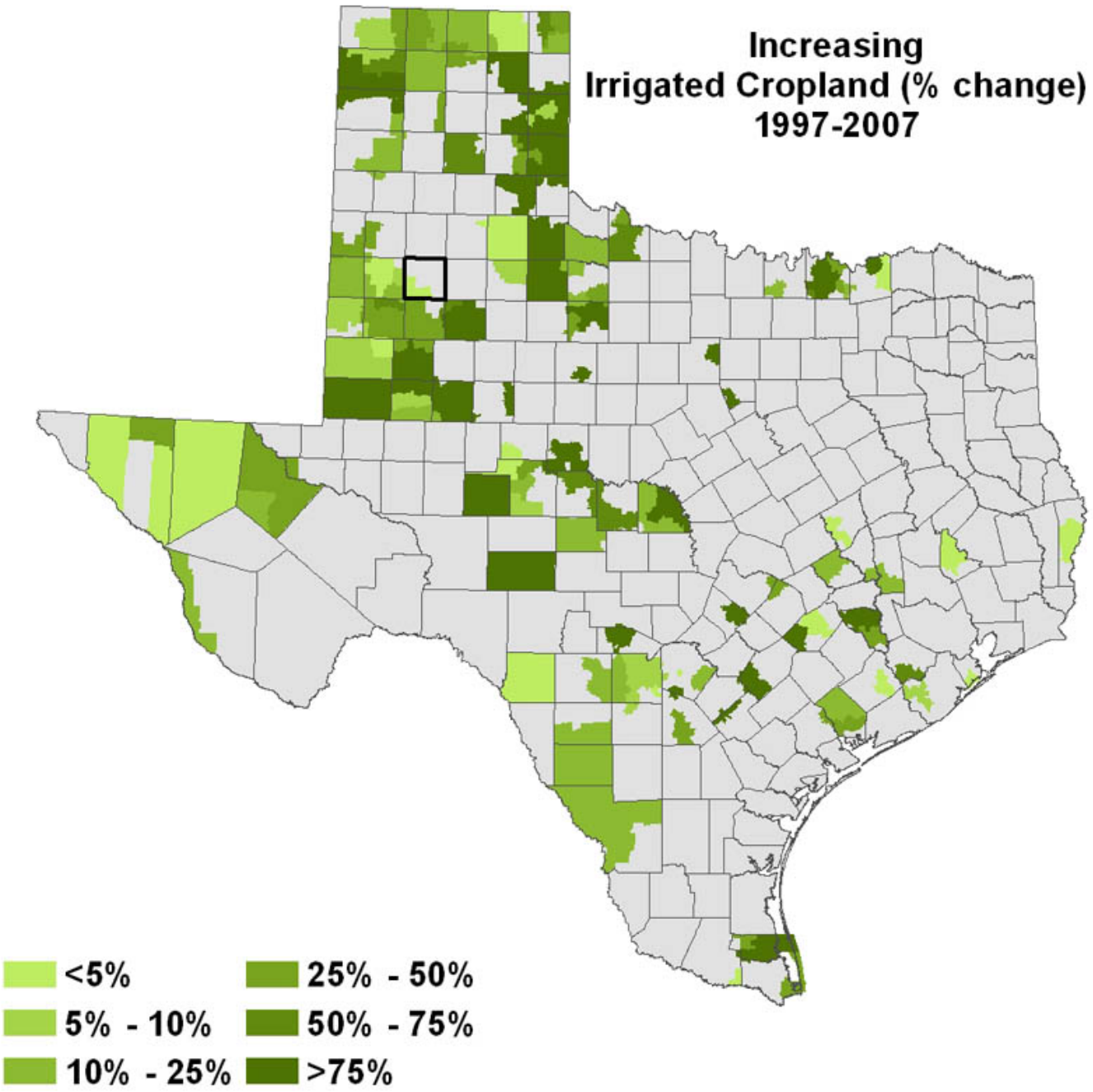
Loss of Agricultural Land 1997-2007

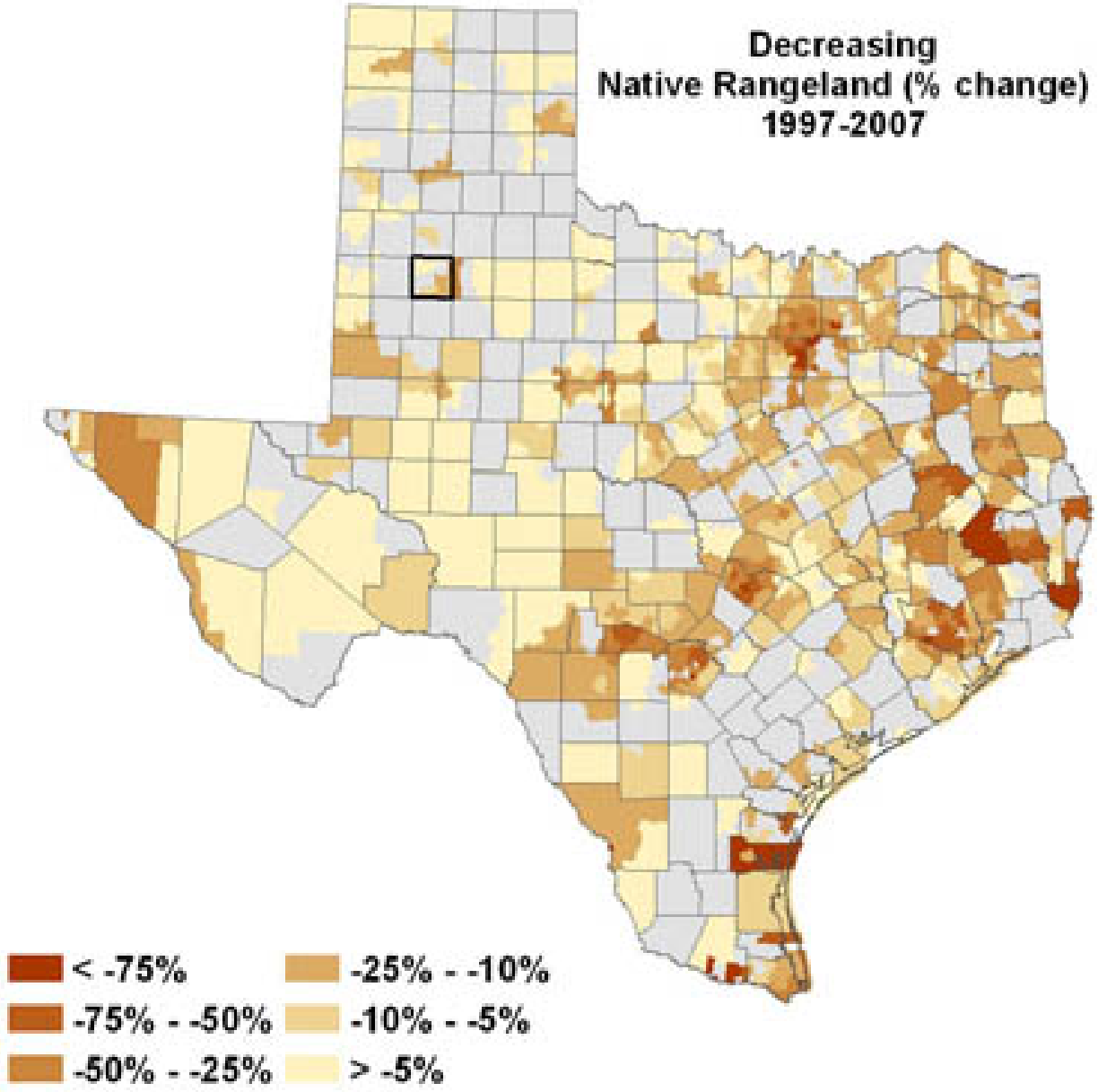
- Urban lights!



Agricultural Intensity




Increasing
Irrigated Cropland (% change)
1997-2007
<5%
5% - 10%
10% - 25%
25% - 50%
50% - 75%
>75%


Decreasing
Native Rangeland (% change)
1997-2007
< -75%
-75% - -50%
-50% - -25%
-25% - -10%
-10% - -5%
> -5%

Understanding Direct & Indirect Consequences of Precipitation Changes

Creosotebush bajada BBNP

Precipitation Sources & Implications

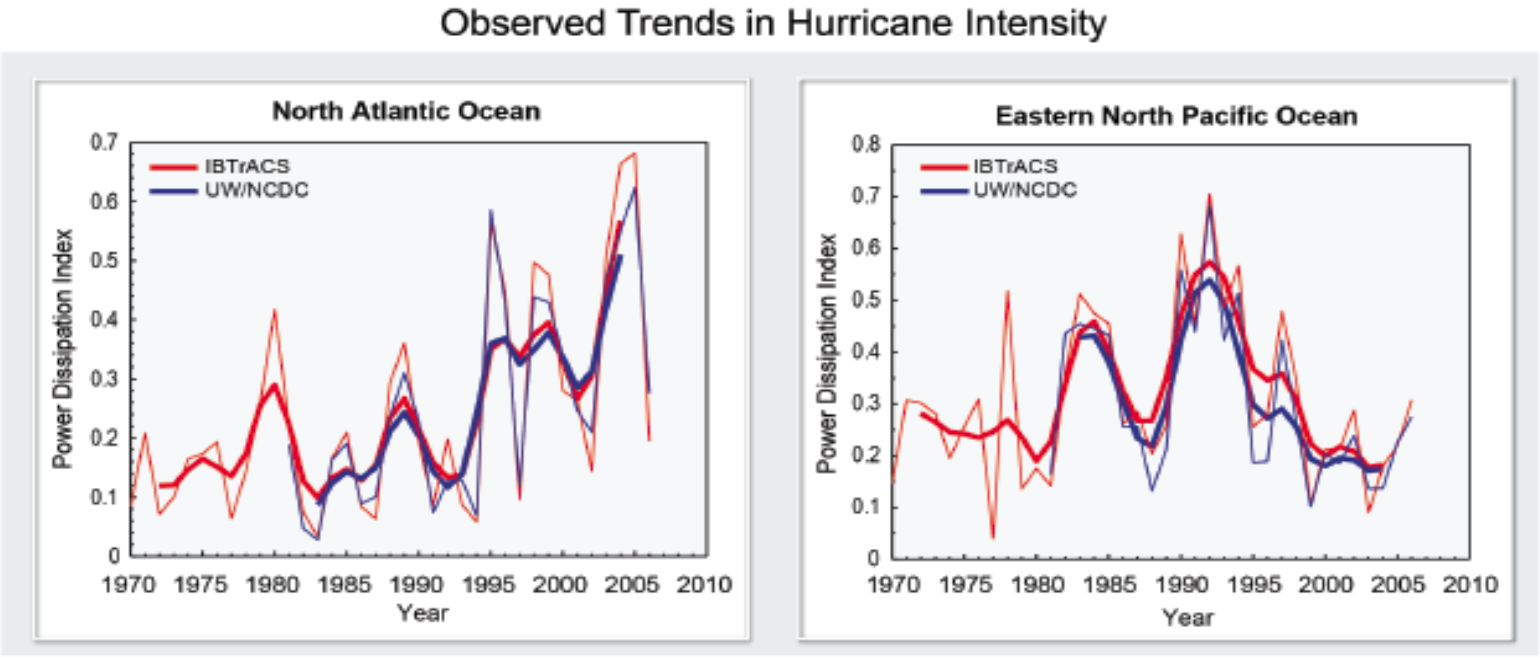


Figure 2.23: Observed Trends in Hurricane Intensity

Caption: Recent variations of the Power Dissipation Index (PDI), a measure of overall hurricane intensity in a hurricane season. Historical and satellite observations show a significant upward trend in the strength of hurricanes and in the number of strong hurricanes (Category 4 and 5) in the North Atlantic from 1983 to 2009. A significant decreasing trend in hurricane intensity is detected for the eastern North Pacific from 1984 to 2009, but no trend in the number of storms is apparent. Updated from (Kossin et al. 2007)

Projected Changes in Atlantic Hurricane Frequency by Category

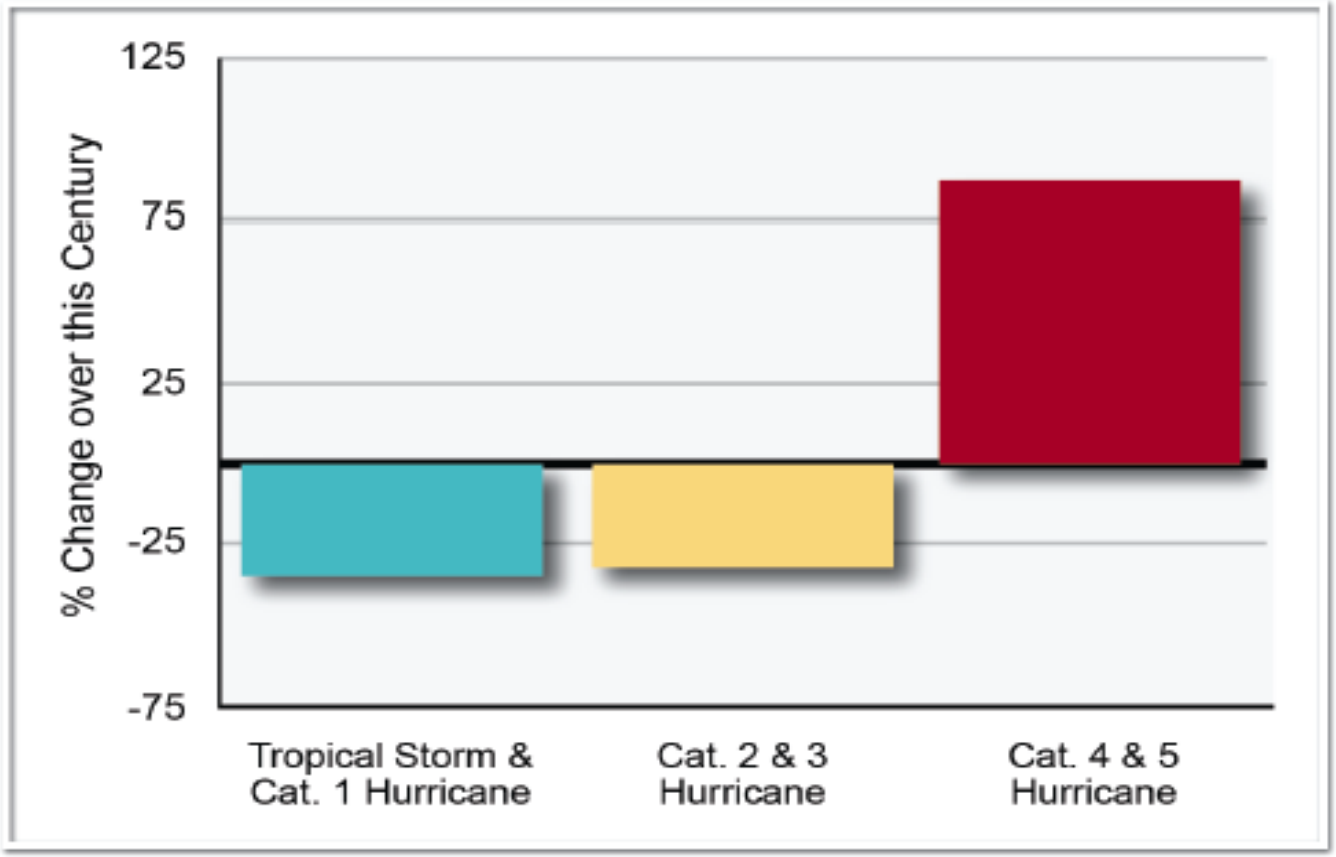
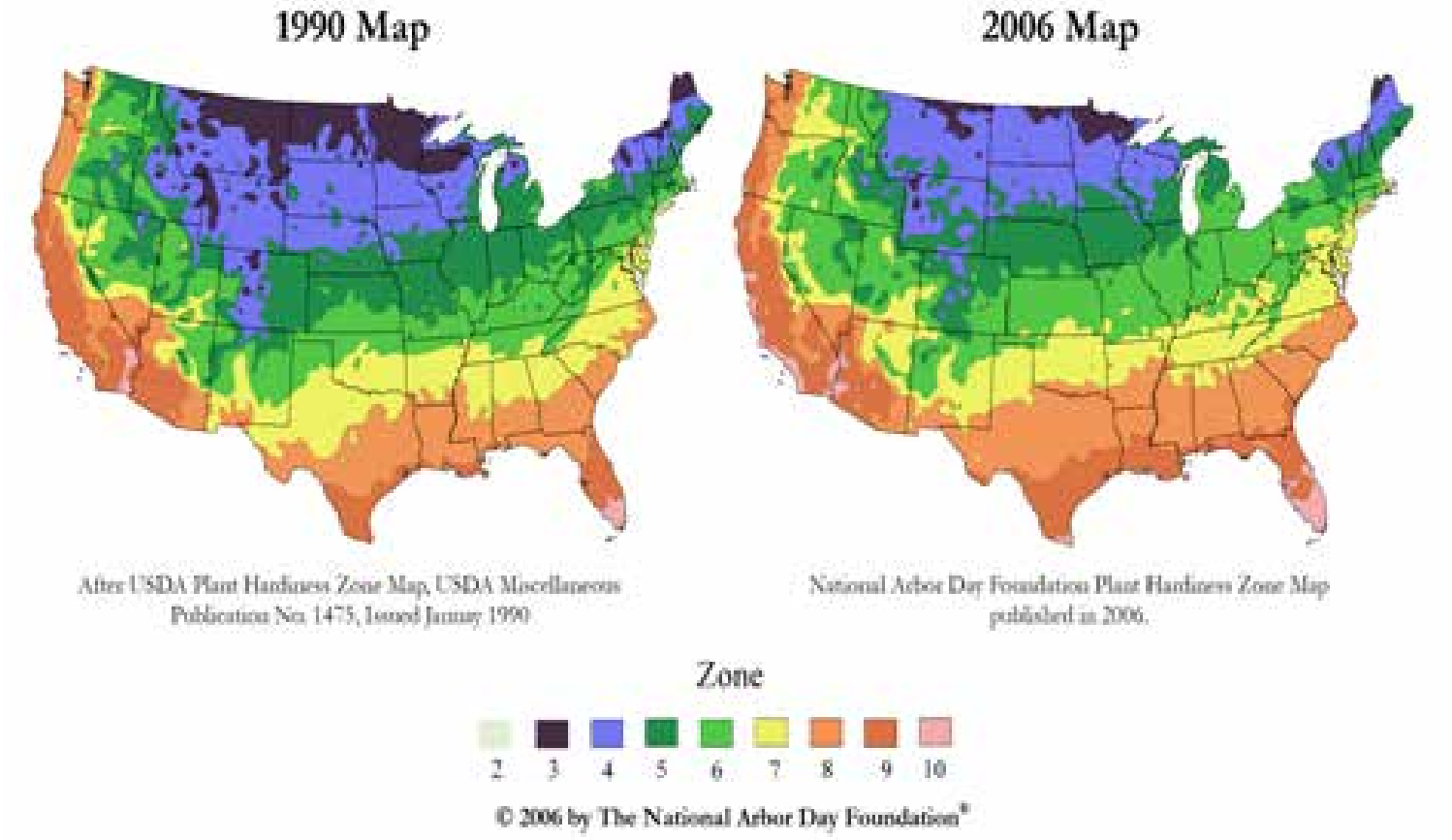


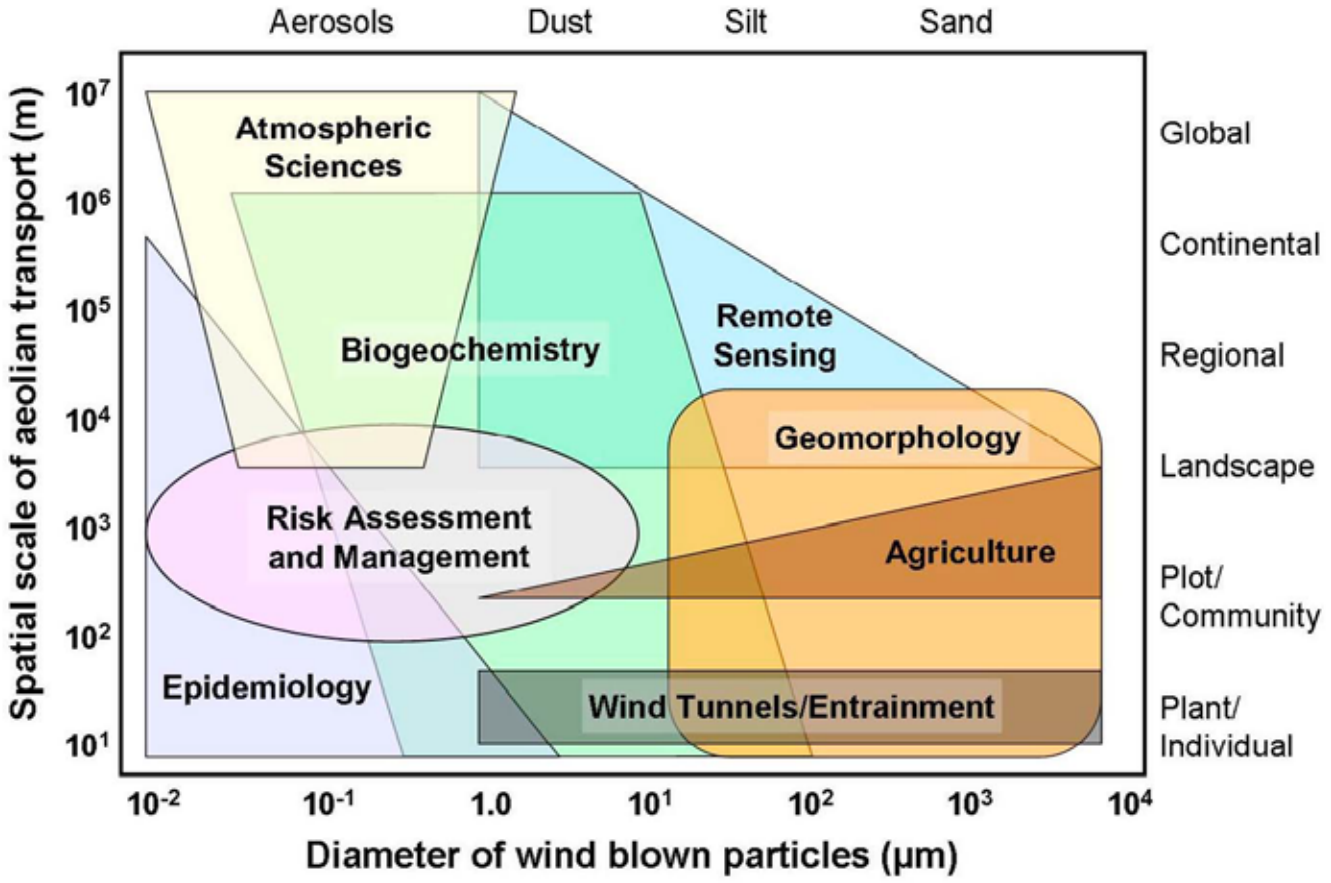
Figure 2.24: Projected Changes in Atlantic Hurricane Frequency by Category

Caption: Model projections of percentage changes in Atlantic hurricane and tropical storm frequencies for different storm categories, by the late this century. Projected changes are for the period 2081-2100 compared with the period 2001-2020. (Figure source: NOAA GFDL)

USDA Plant Hardiness Maps

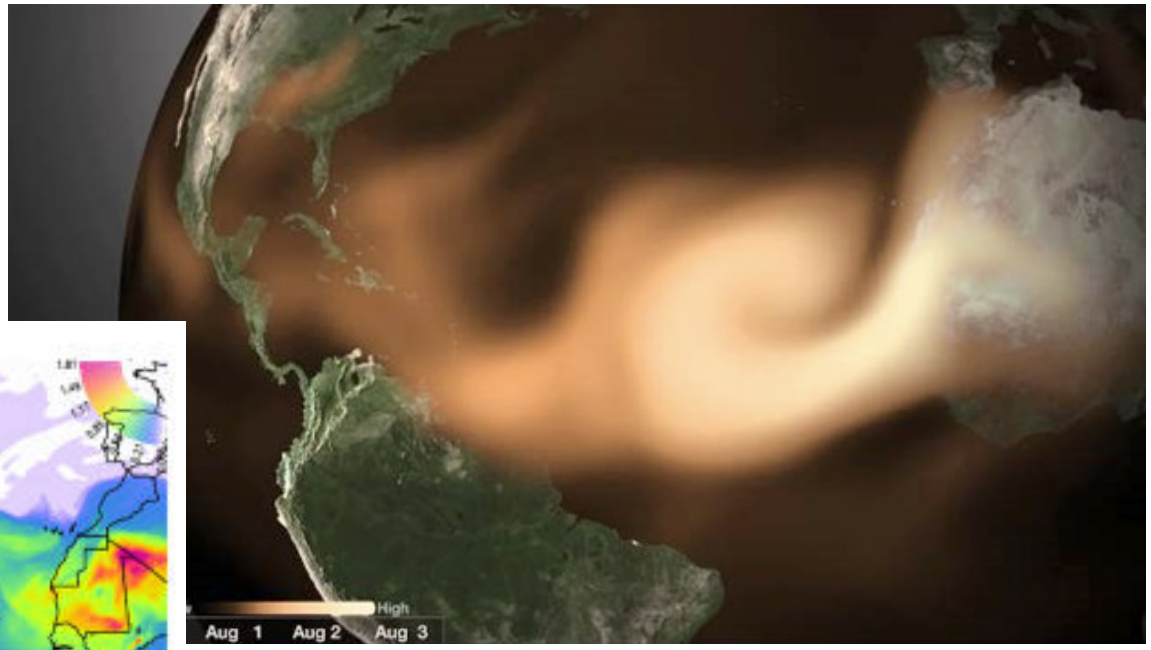


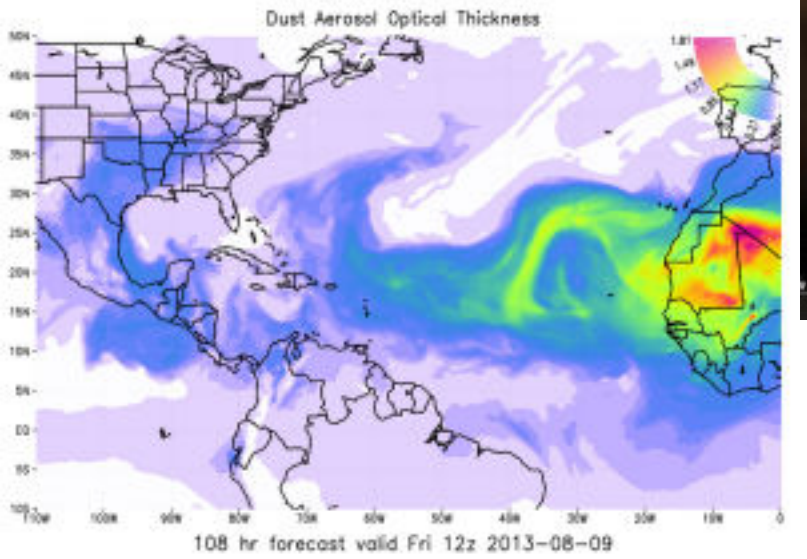
Aeolian Impacts and Scale (from Ravi et al. 2011)



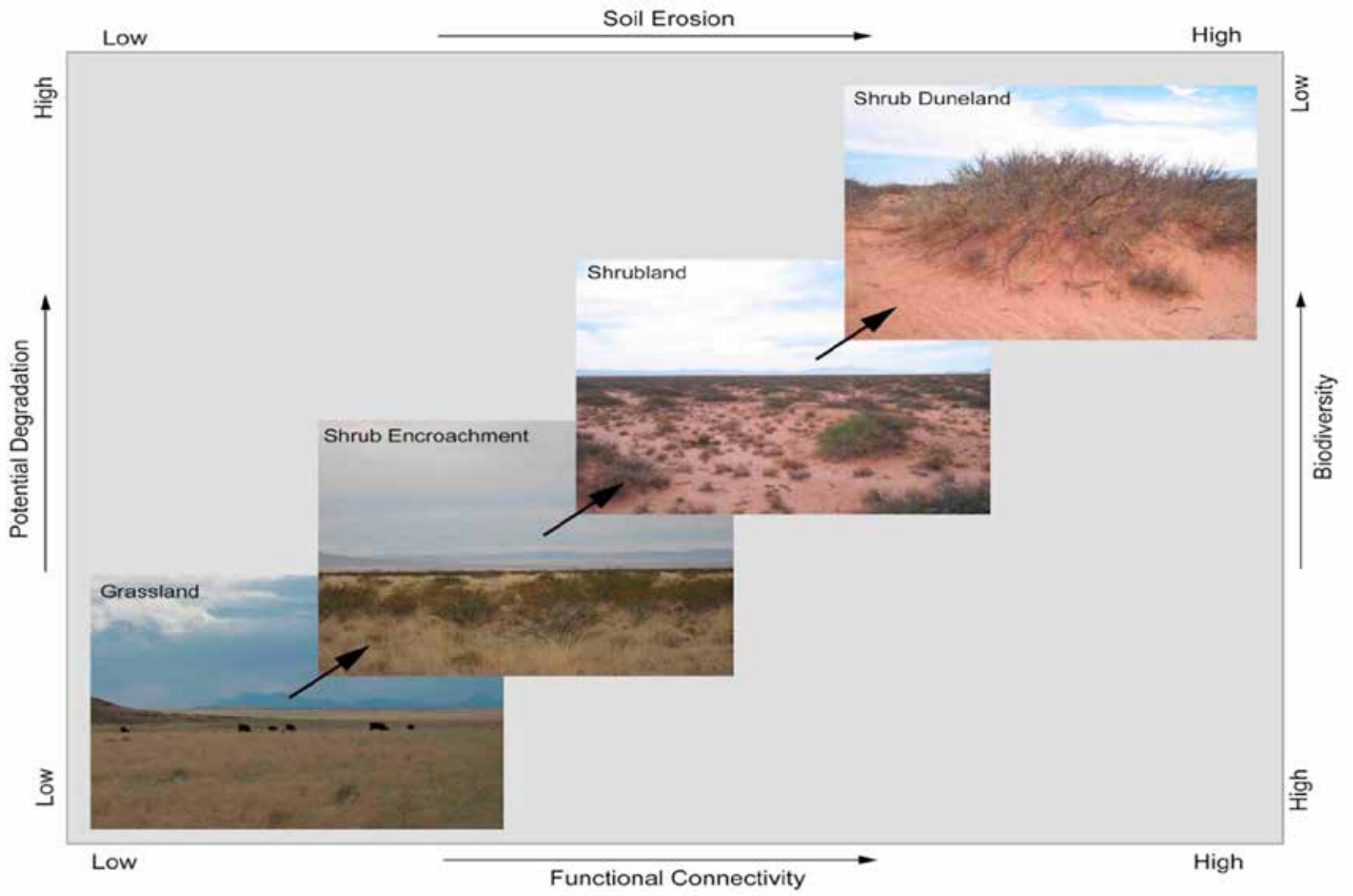
Global Consequence of Dust

- Dust from Sahara deposited in TX – August 2013





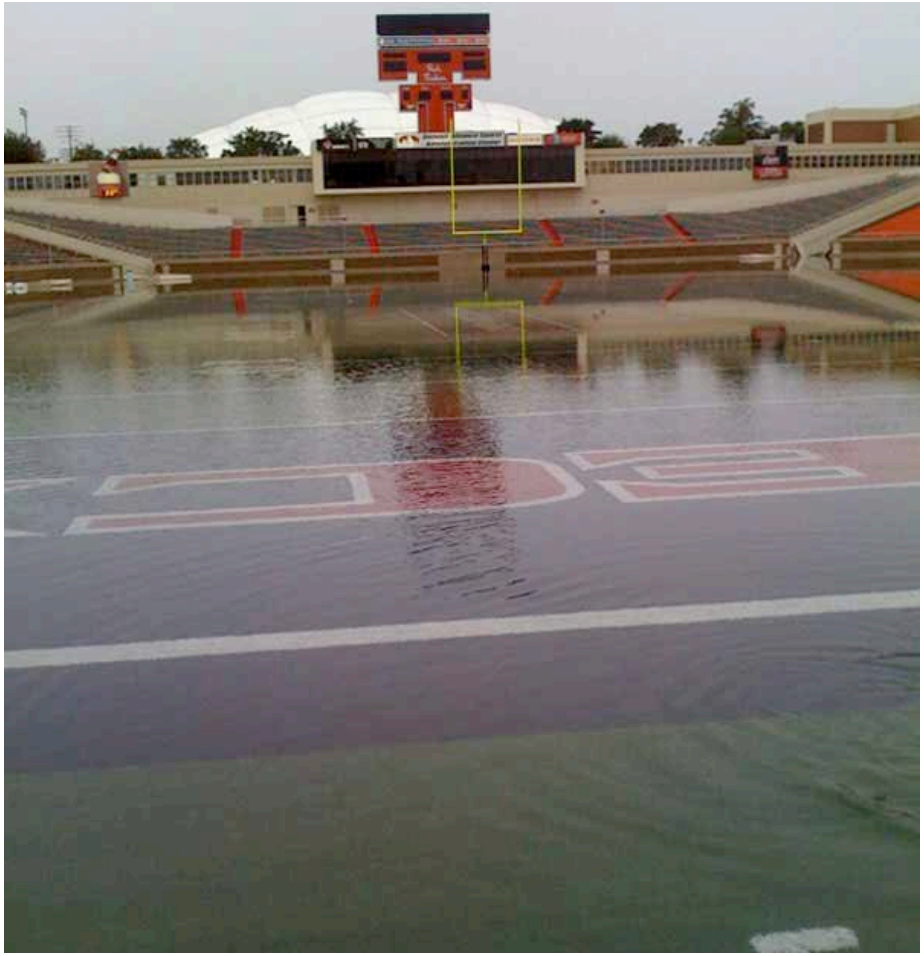
Land degradation in the Chihuahuan Desert along with changes in functional connectivity, soil erosion rates, and biodiversity [from Ravi et al., 2010].



What does Climate Variability Look Like in the South Central Region?

Section 3

What does Climate Variability Look Like?



Jones Stadium, September 2010

What does Climate Variability Look Like?

Jones Stadium, October 2011

What does Climate Variability Look Like

- **I-40 around Amarillo in late April, 2012**

What does Climate Variability Look Like?

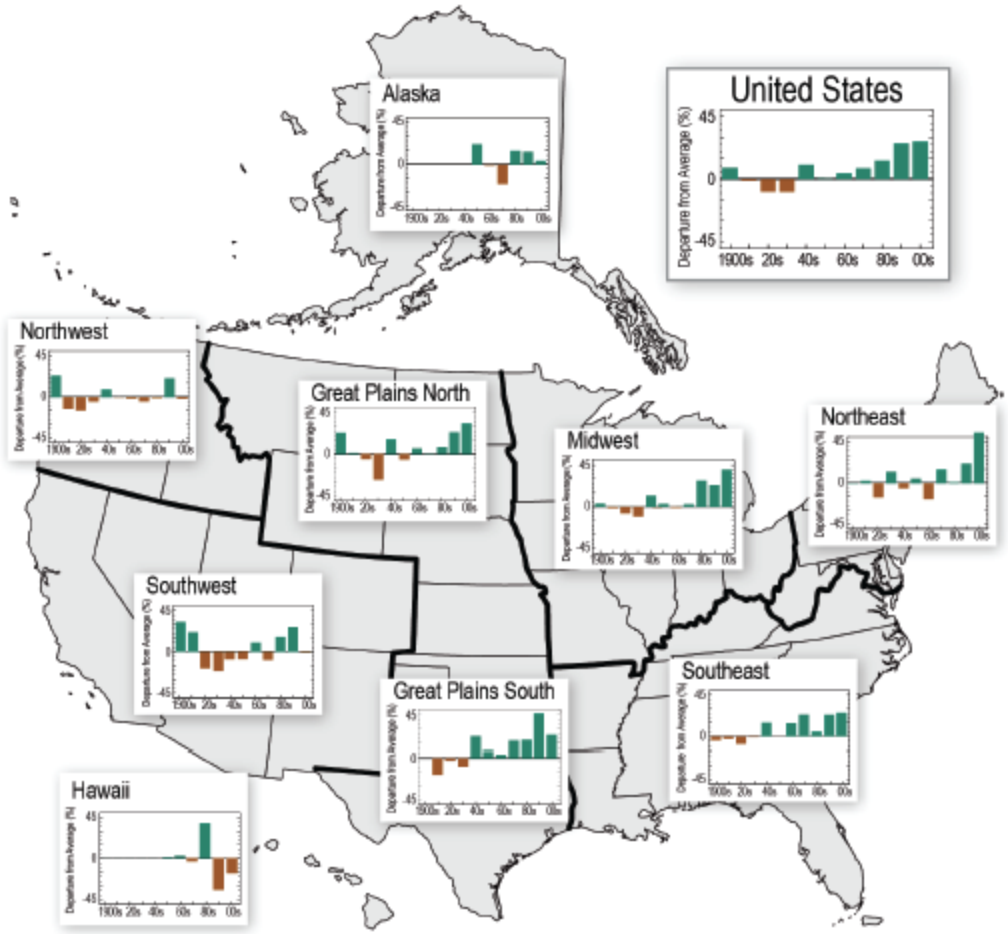
How Has Climate Changed in the SCR?

Section 4

Temperature

- **Annual temperatures are rising.**
- **Winter temperatures have warmed the most**
- **Cold spells are becoming less severe and less frequent**

Observed Changes in Heavy Precipitation (Figure from NOAA)



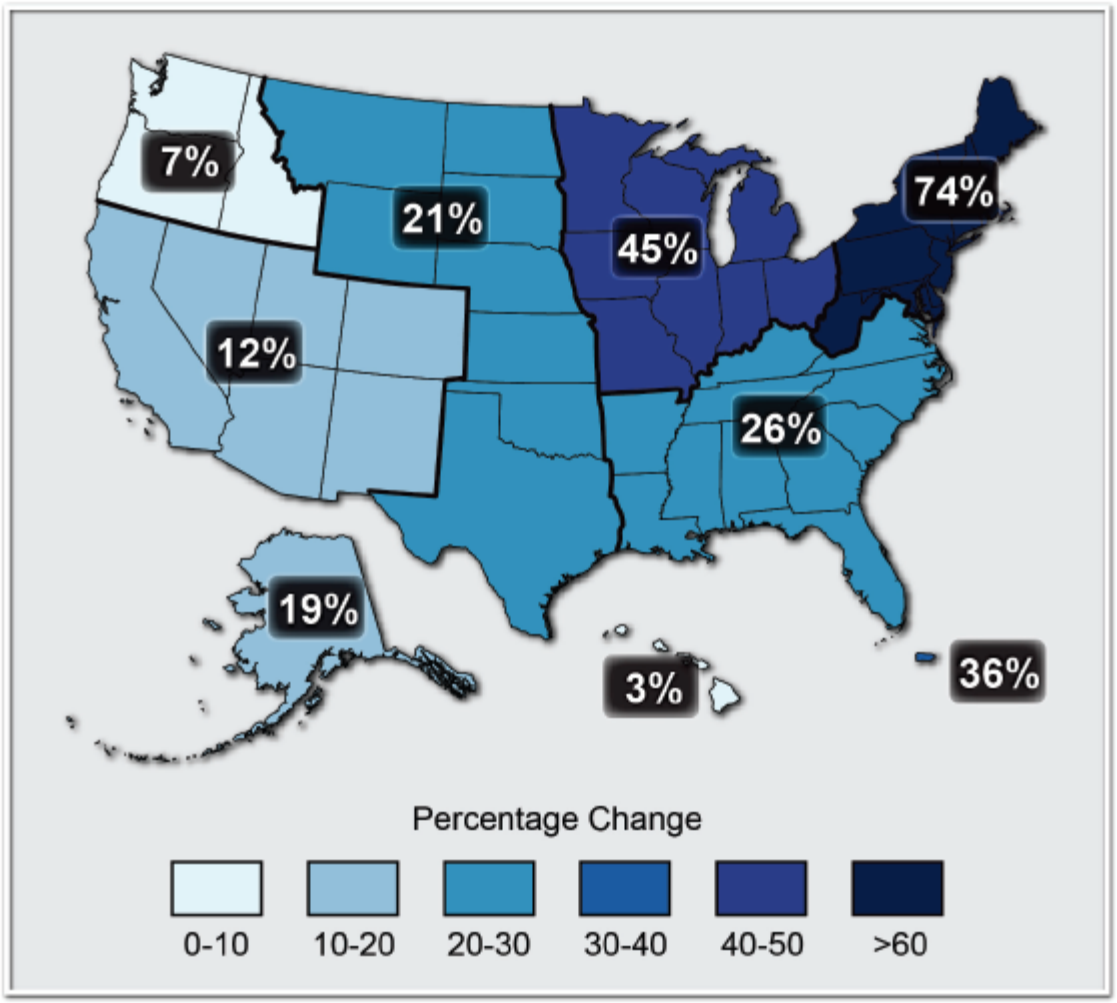
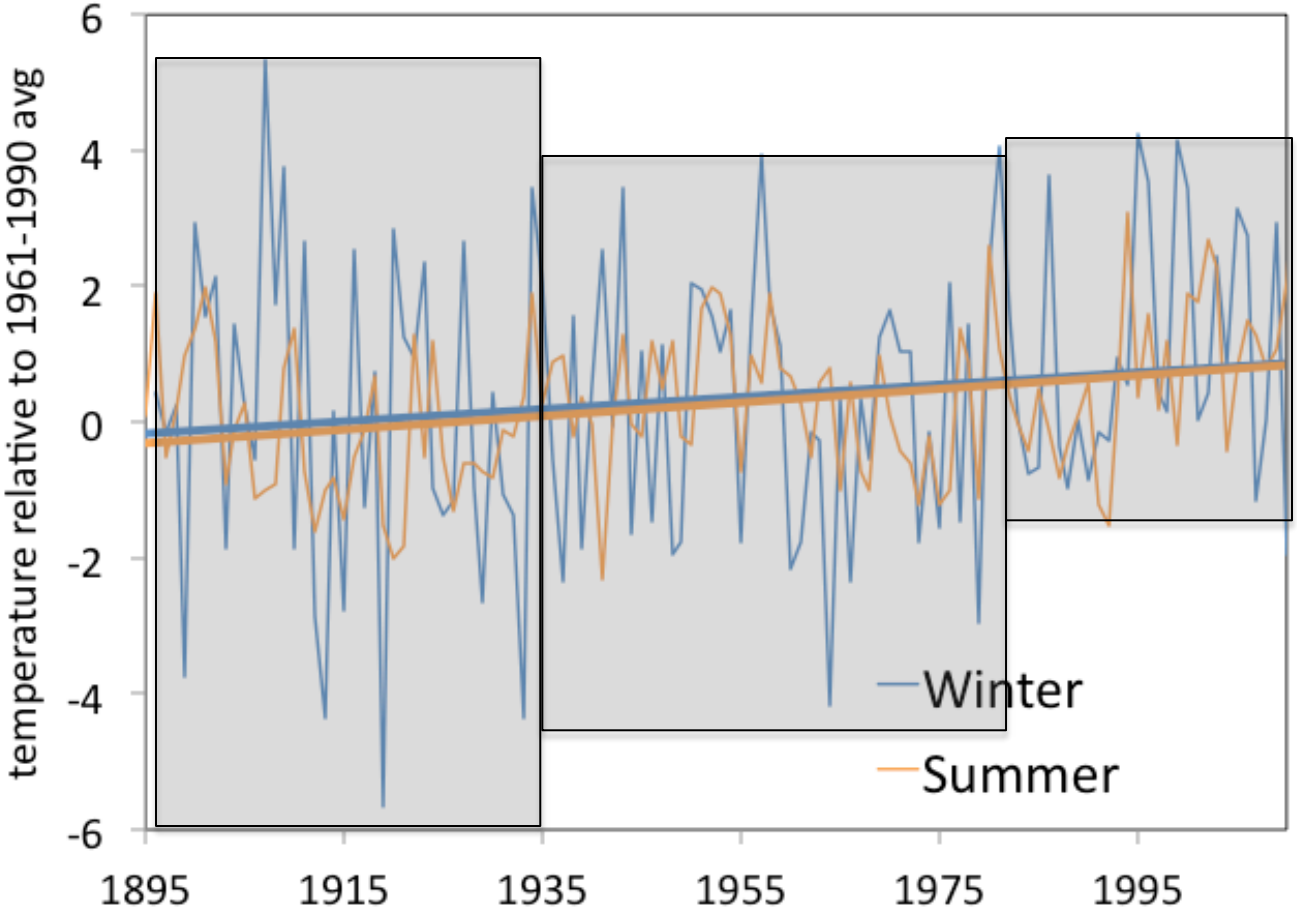


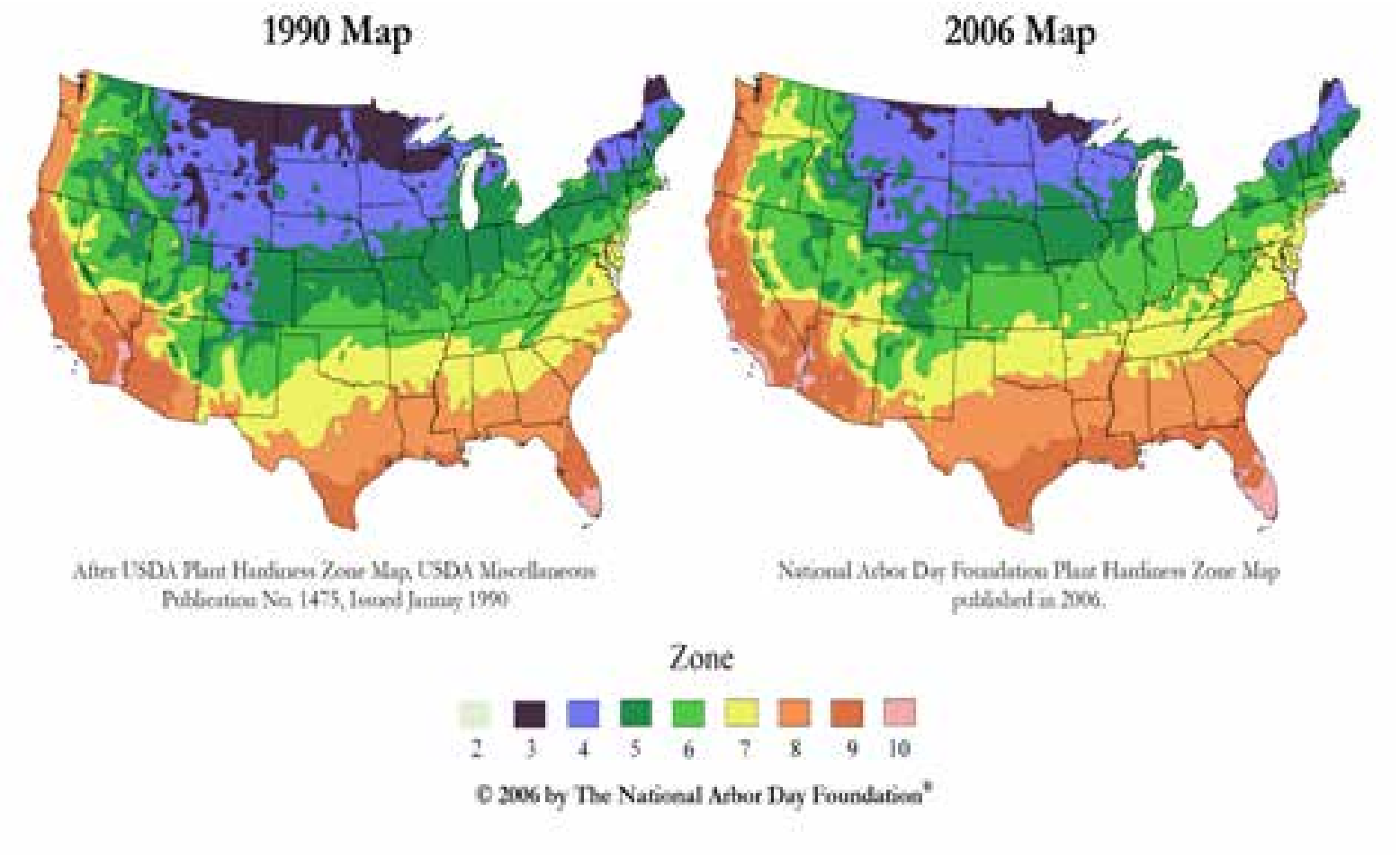
Figure 2.16: Percentage Change in Very Heavy Precipitation

Caption: The map shows percent increases in the amount of precipitation falling in *very heavy* events (defined as the heaviest 1% of all daily events) from 1958 to 2011 for each region. There are clear trends toward a greater amount of *very heavy* precipitation for the nation as a whole, and particularly in the Northeast and Midwest. (Figure source: updated from (Karl et al. 2009) with data from NCDC)

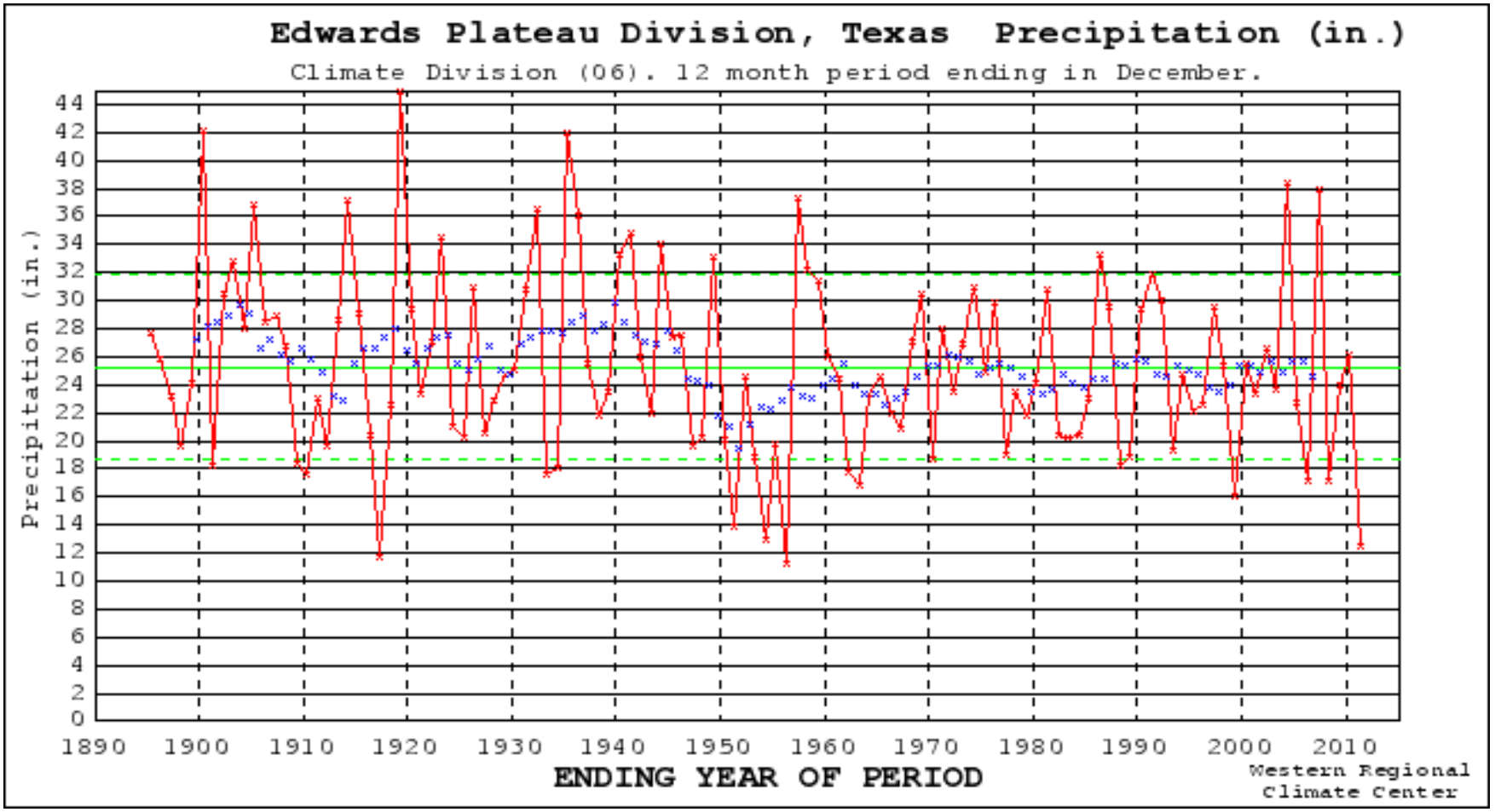
How Has Texas Climate Changed?



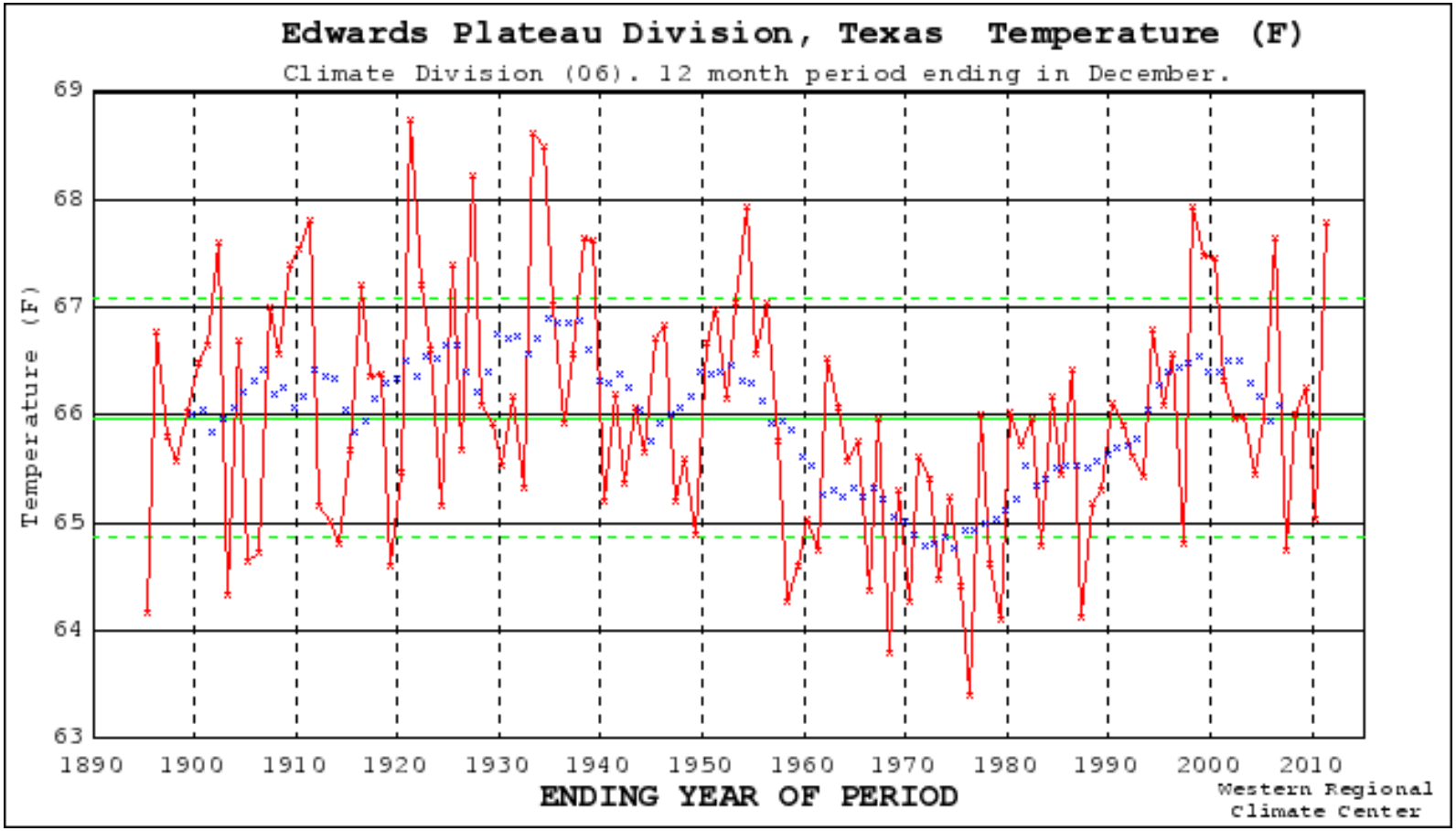
USDA Plant Hardiness Maps



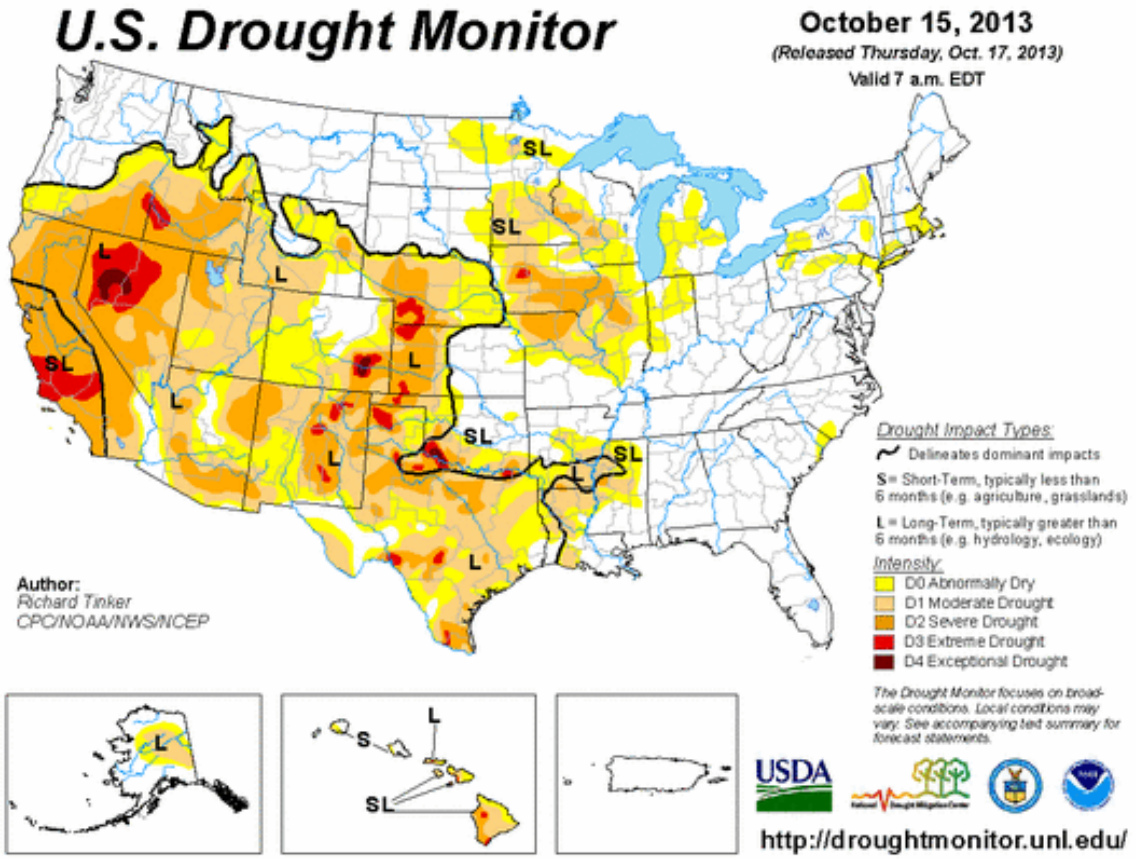
Edwards Plateau Precipitation Variability



Edwards Plateau Average Yearly Temperature Variability



Current Drought Status

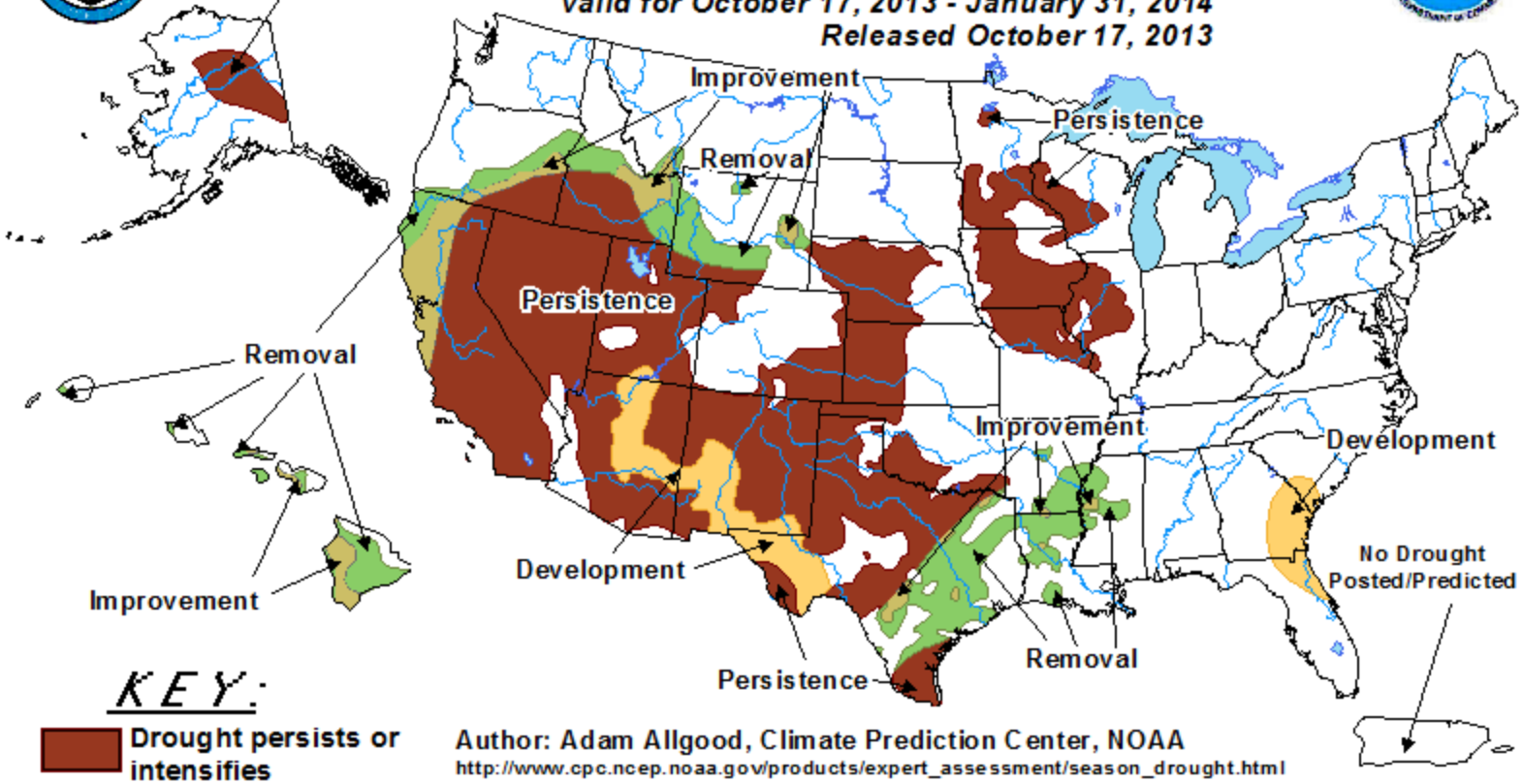


U.S. Seasonal Drought Outlook

Drought Tendency During the Valid Period

Valid for October 17, 2013 - January 31, 2014

Released October 17, 2013



KEY:

- **Drought persists or intensifies**
- **Drought remains but improves**
- **Drought removal likely**
- **Drought development likely**

Author: Adam Allgood, Climate Prediction Center, NOAA

http://www.cpc.ncep.noaa.gov/products/expert_assessment/season_drought.html

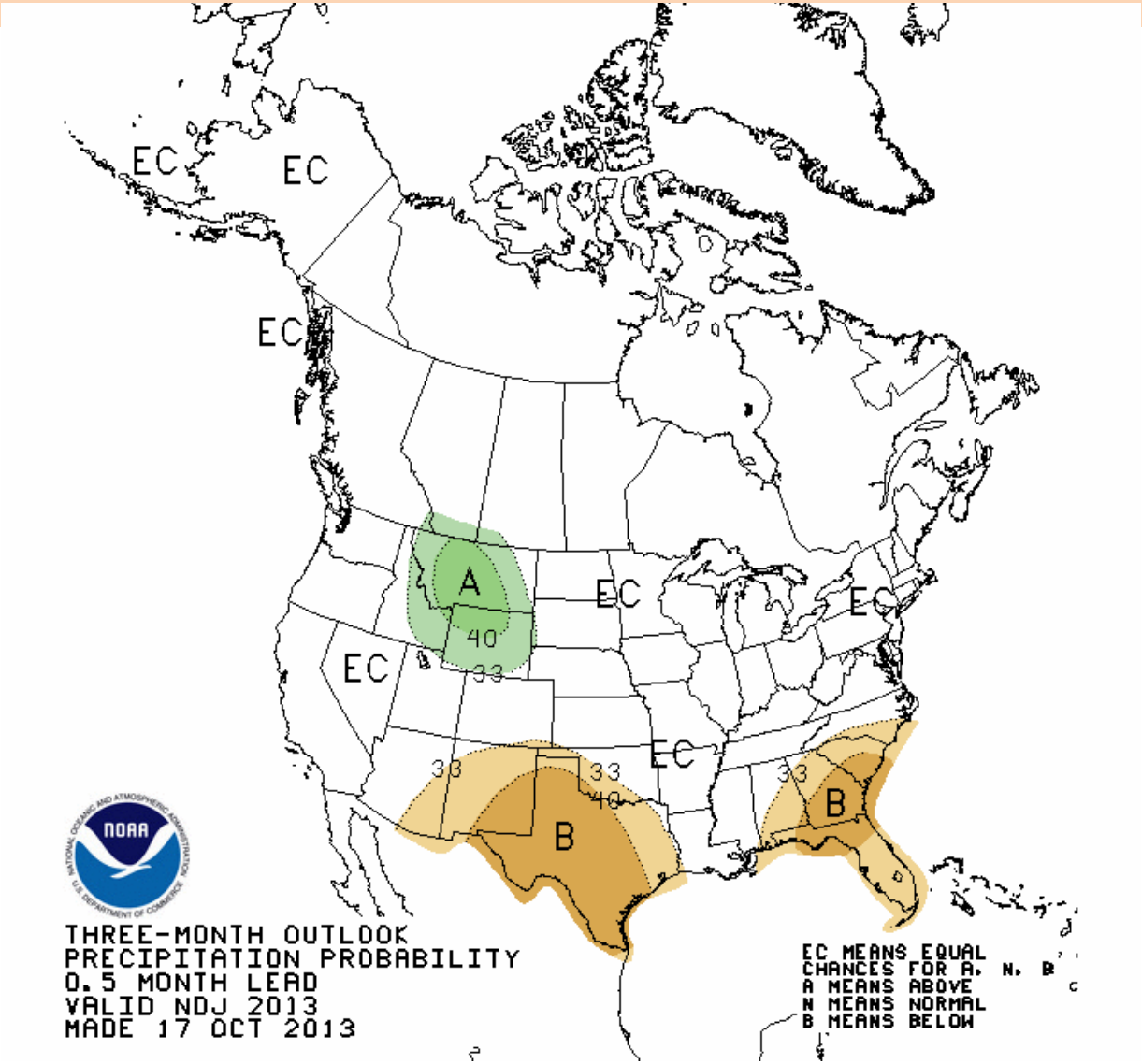
Depicts large-scale trends based on subjectively derived probabilities guided by short- and long-range statistical and dynamical forecasts. Short-term events -- such as individual storms -- cannot be accurately forecast more than a few days in advance. Use caution for applications -- such as crops -- that can be affected by such events. "Ongoing" drought areas are approximated from the Drought Monitor (D1 to D4 intensity).

For weekly drought updates, see the latest U.S. Drought Monitor.

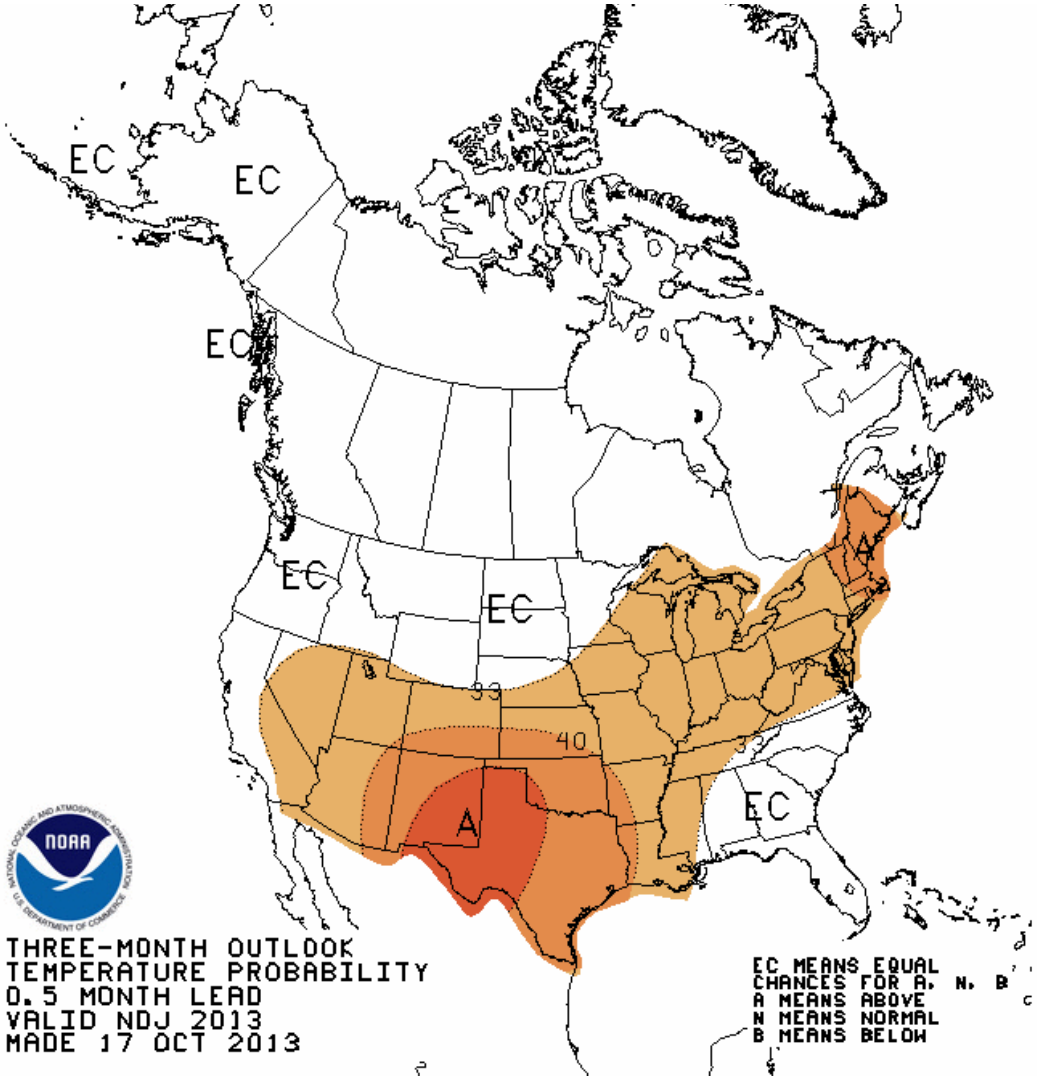
NOTE: The tan area areas imply at least a 1-category improvement in the Drought Monitor intensity levels by the end of the period although drought will remain.

The Green areas imply drought removal by the end of the period (D0 or none)

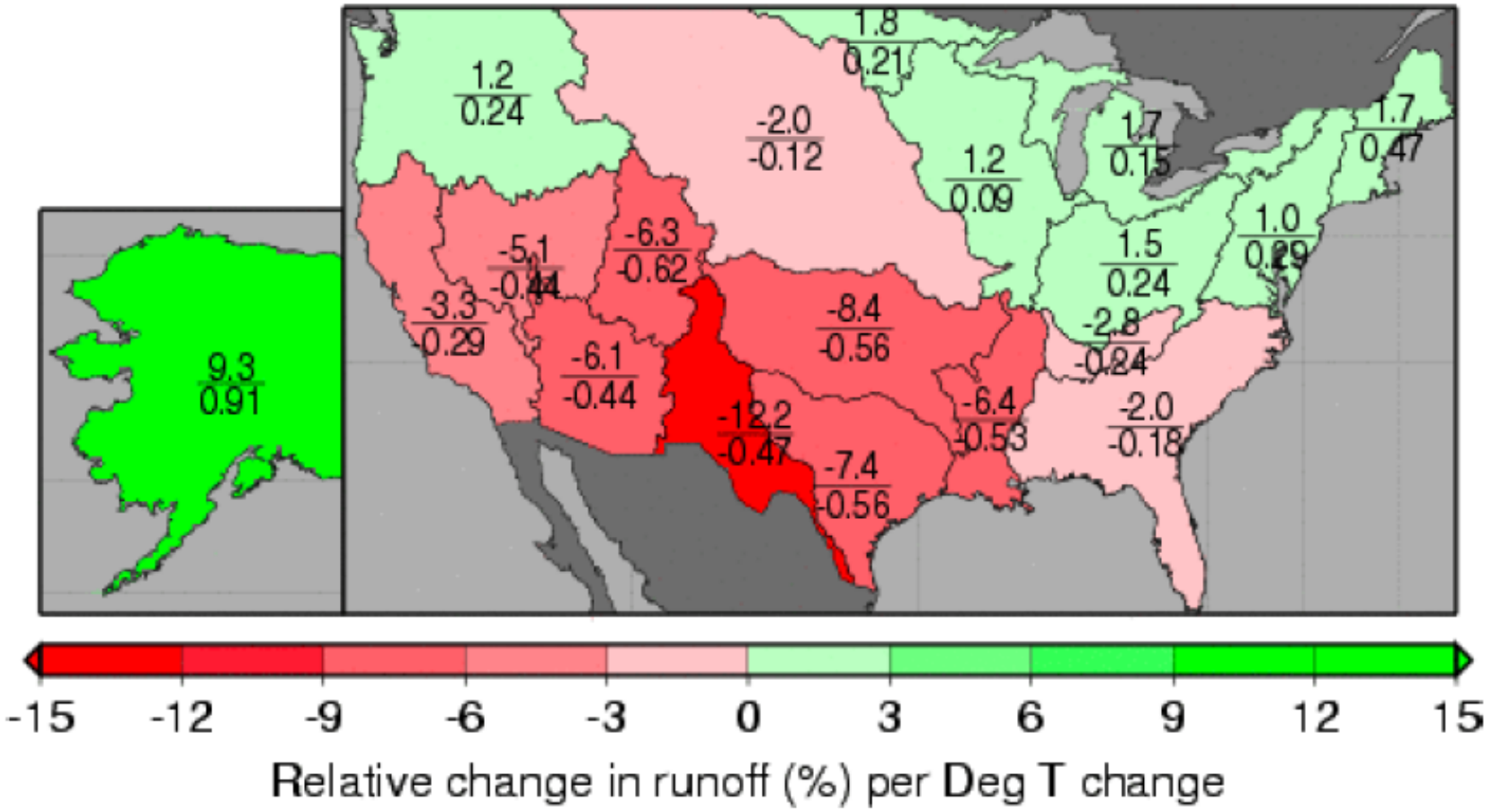
NOAA 3-month Outlook



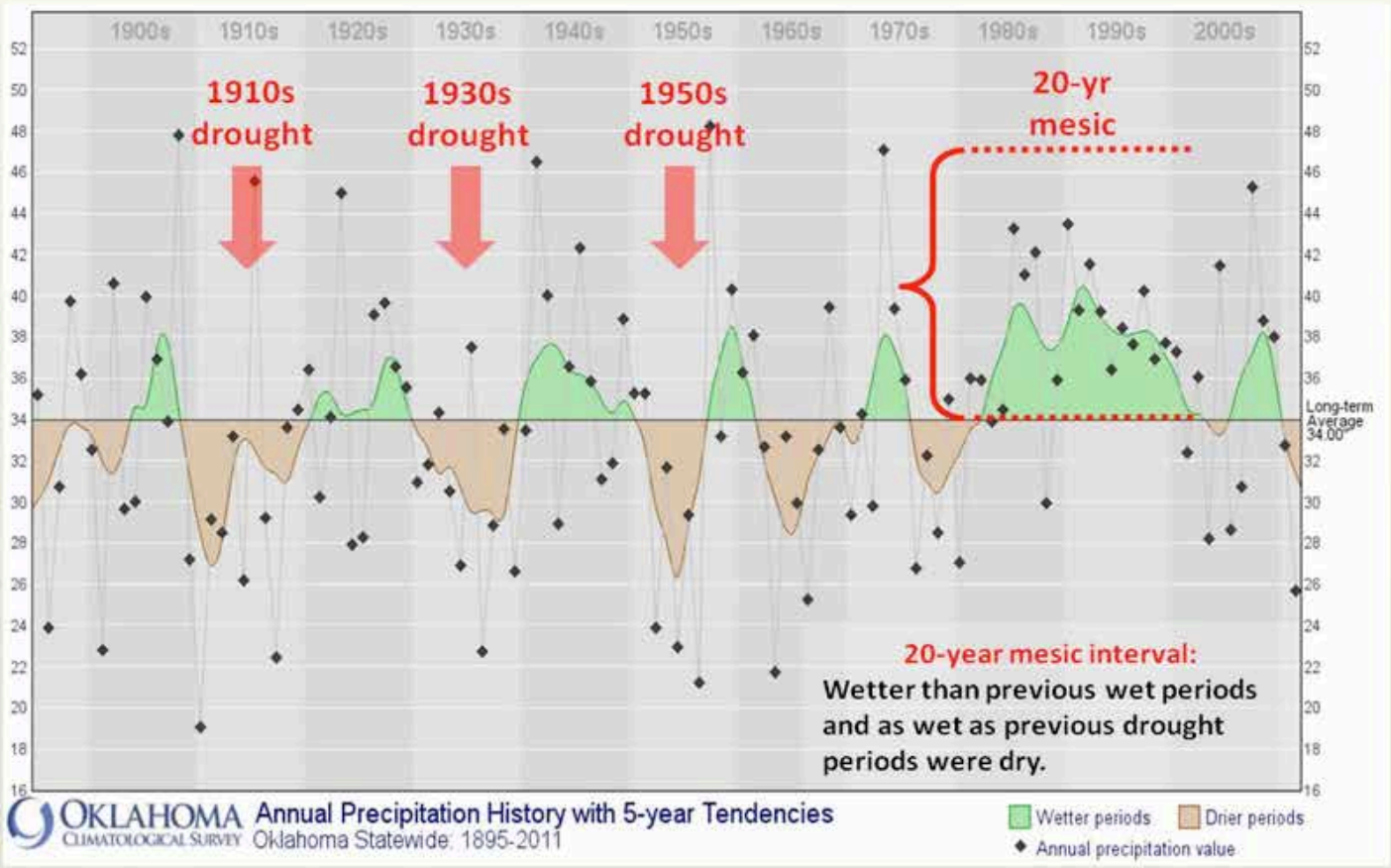
NOAA 3 Month Temperature Projection



Decreases in surface water



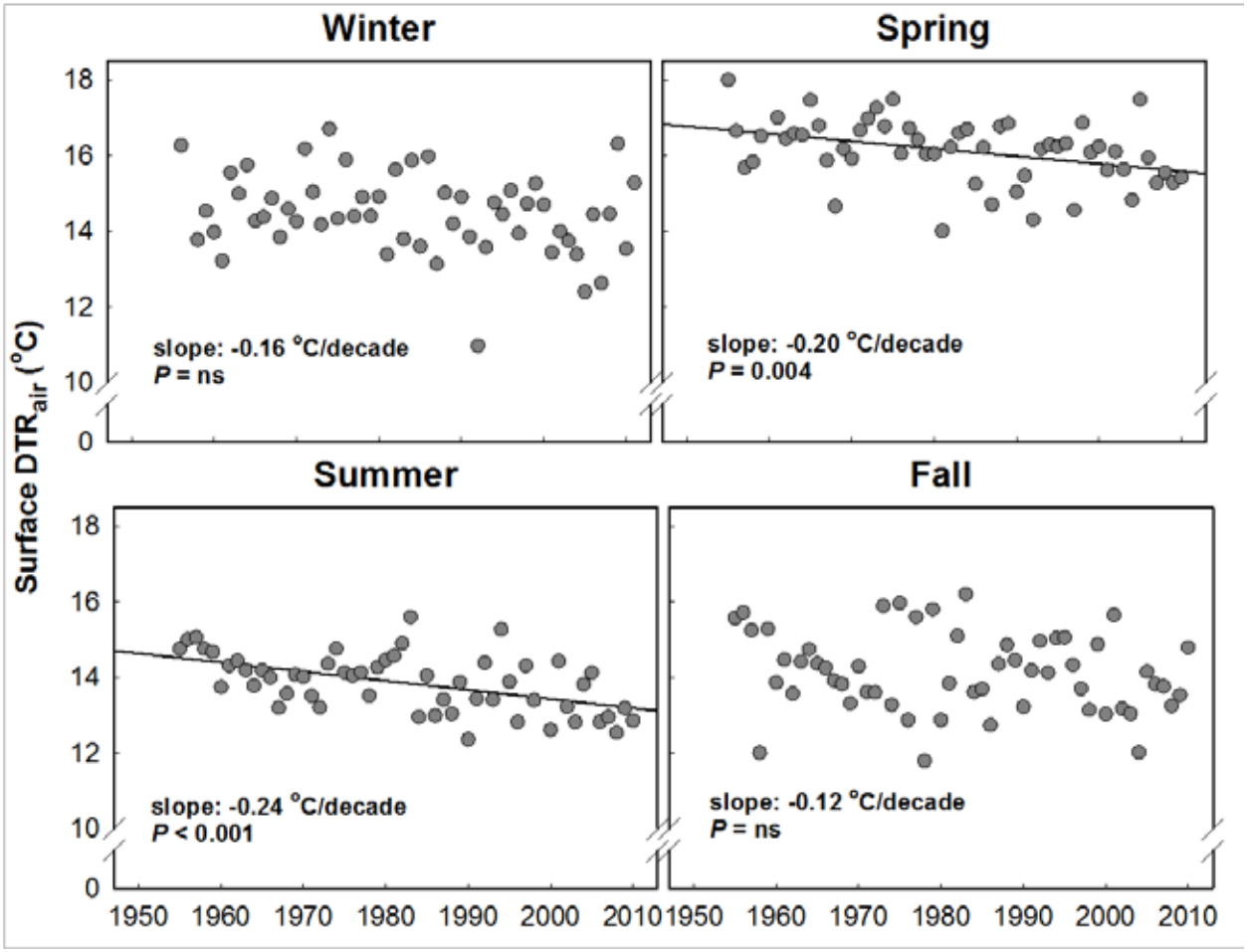
Variability of Precipitation



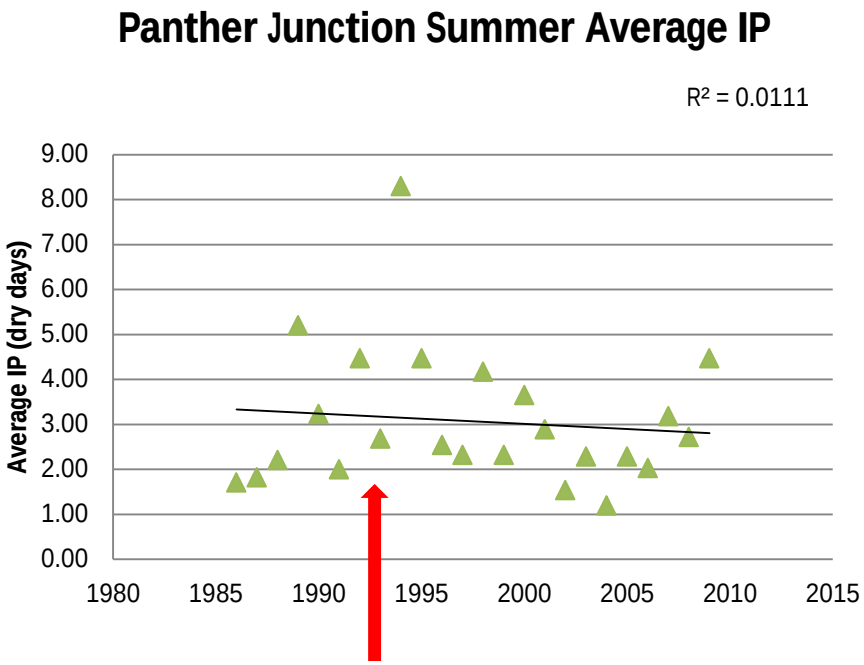
How Small Scale Can Influence Everything

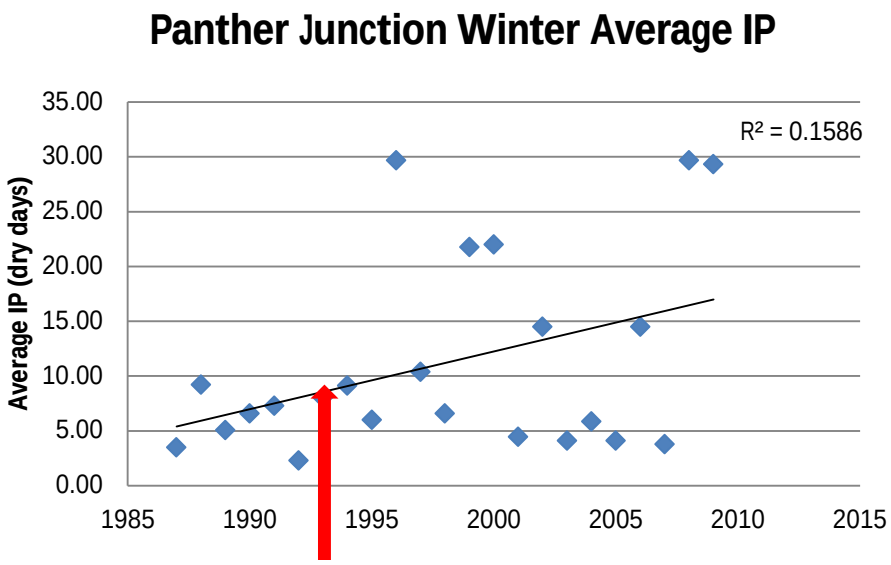
- **Section 5**

Big Bend NP

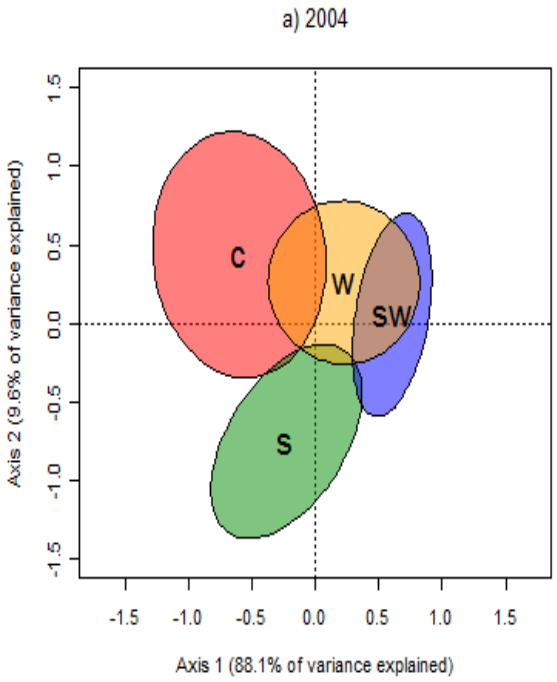


Changing Precipitation Patterns: BBNP

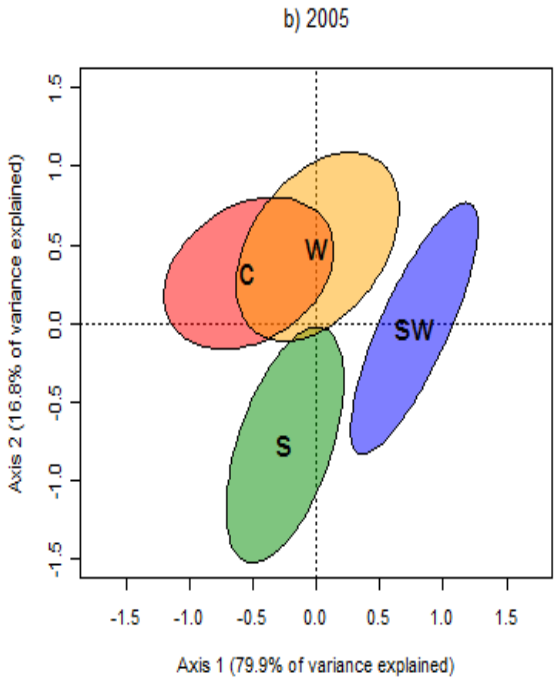




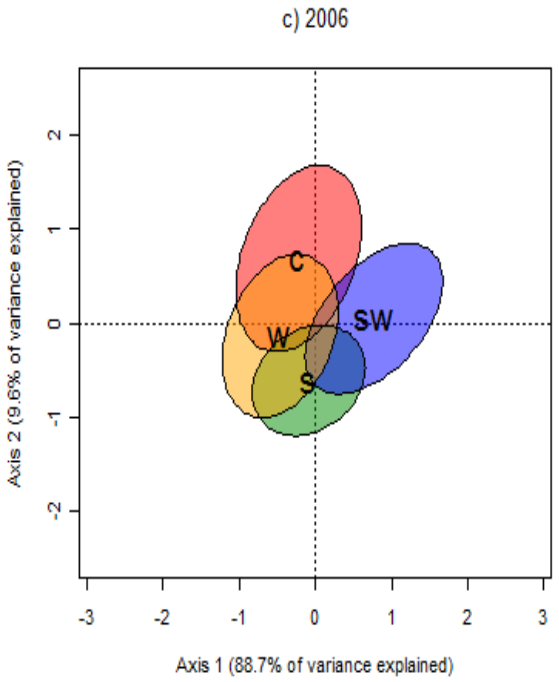
Soil Microbial Responses to Precipitation Changes: BBNP



Wet



Dry

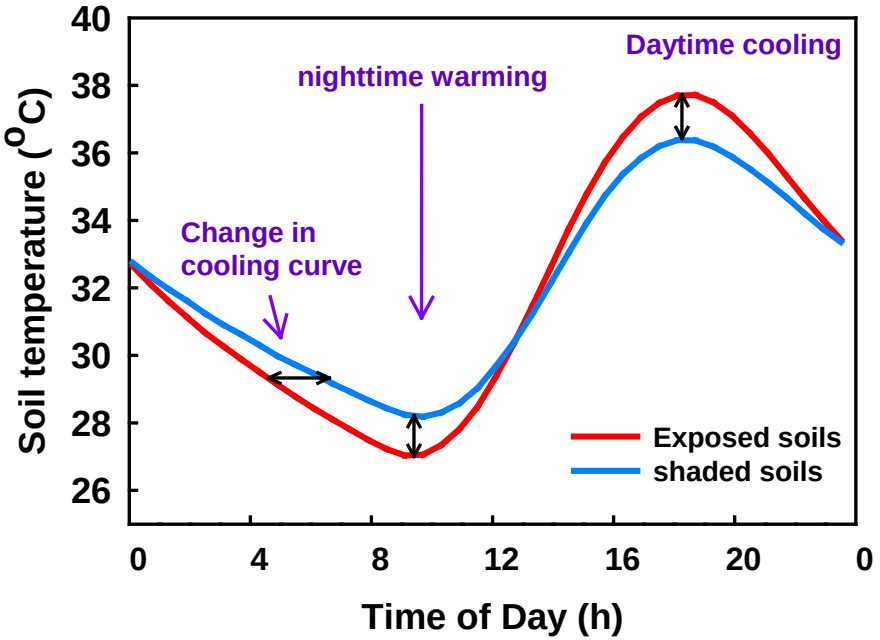


Very Dry

What Controls the Functioning of Arid Systems?

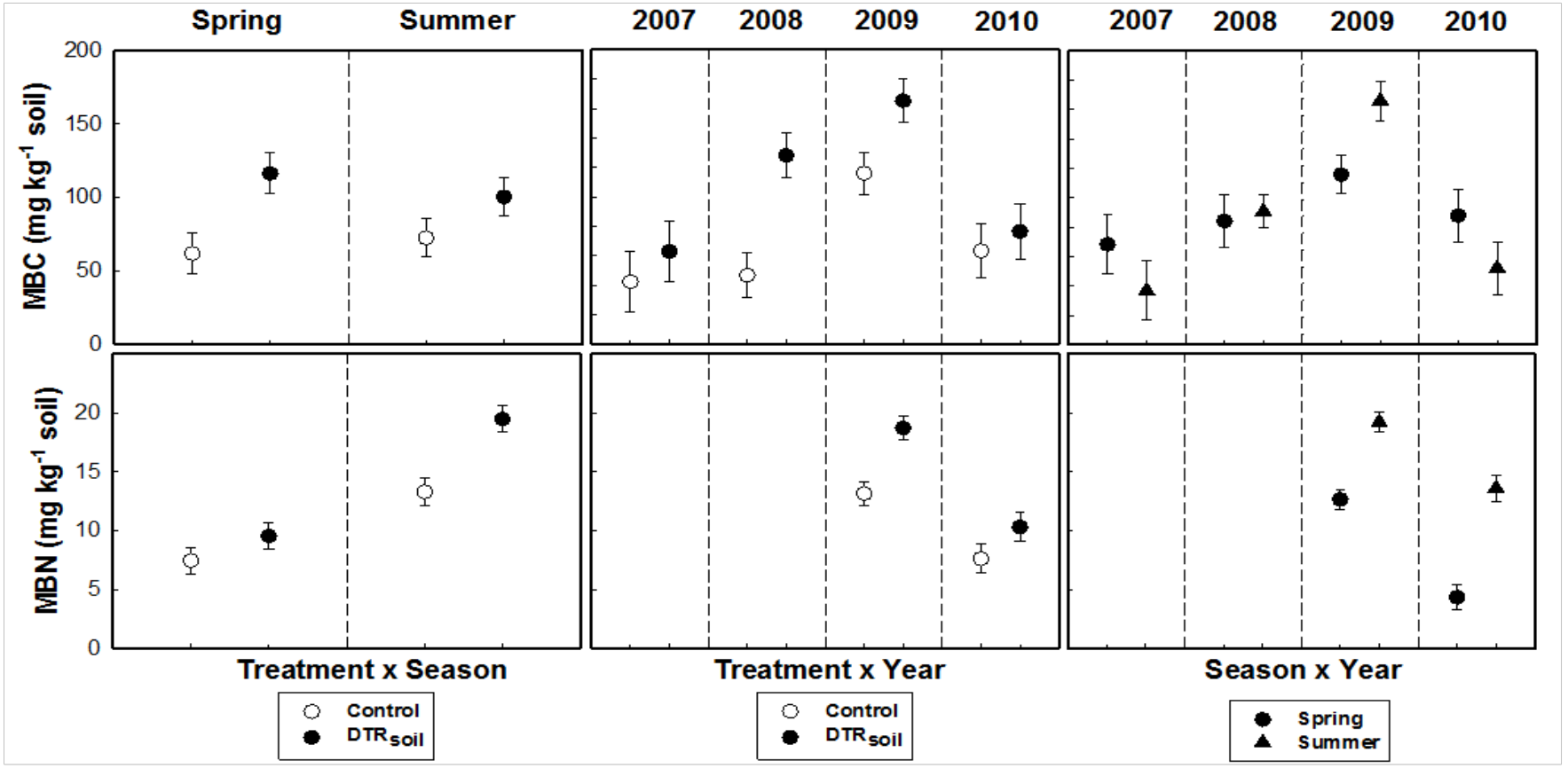
Modifying DTR soil at BBNP

Understanding DTRsoil



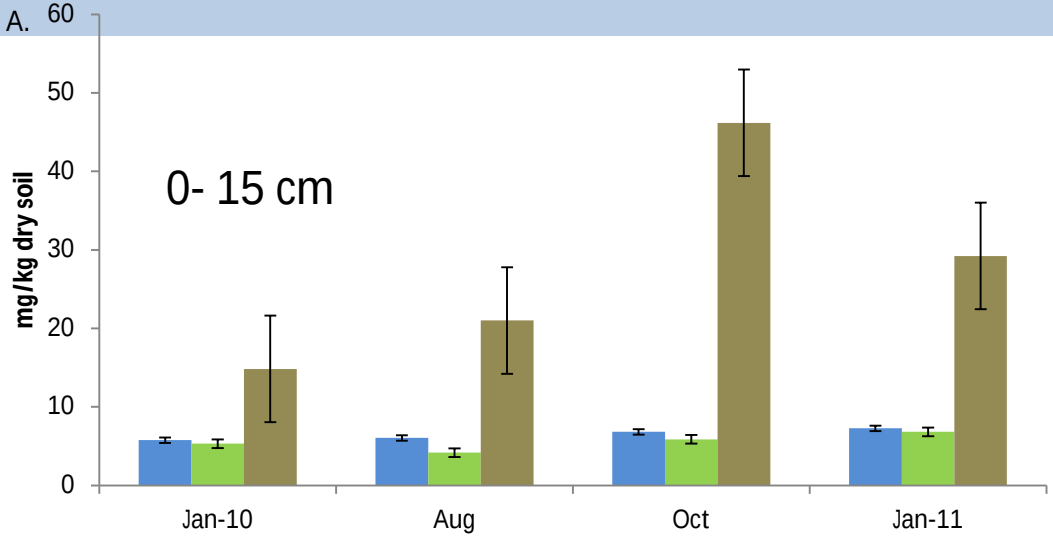
Effects of DTR_{soil} on Microbial Activity

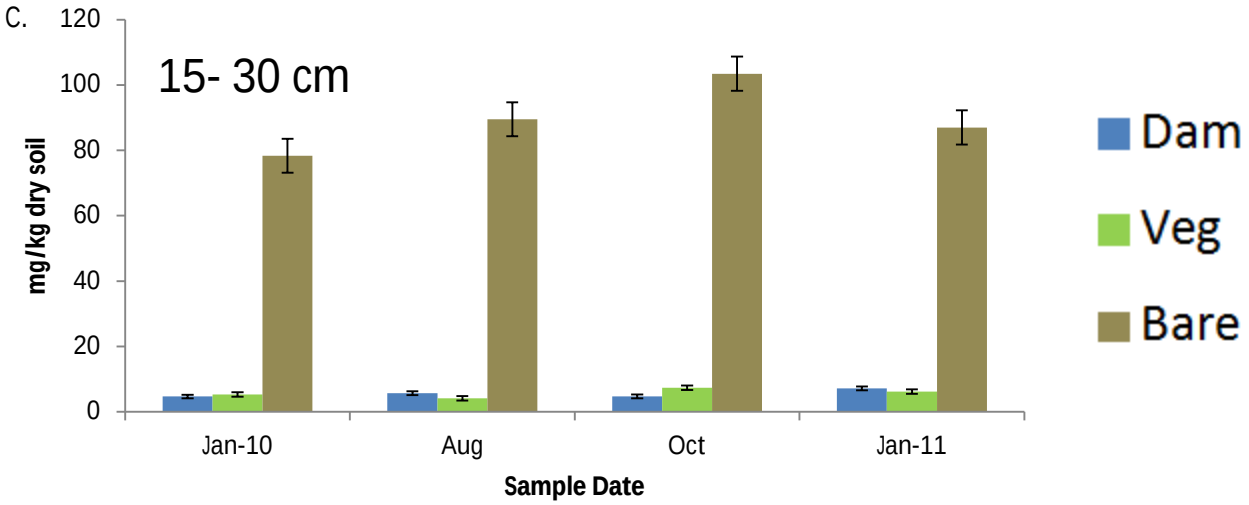
(van Gestel)



Grassland Restoration and DTR_{soil}

No_3 Dynamics: North Rosillos Site

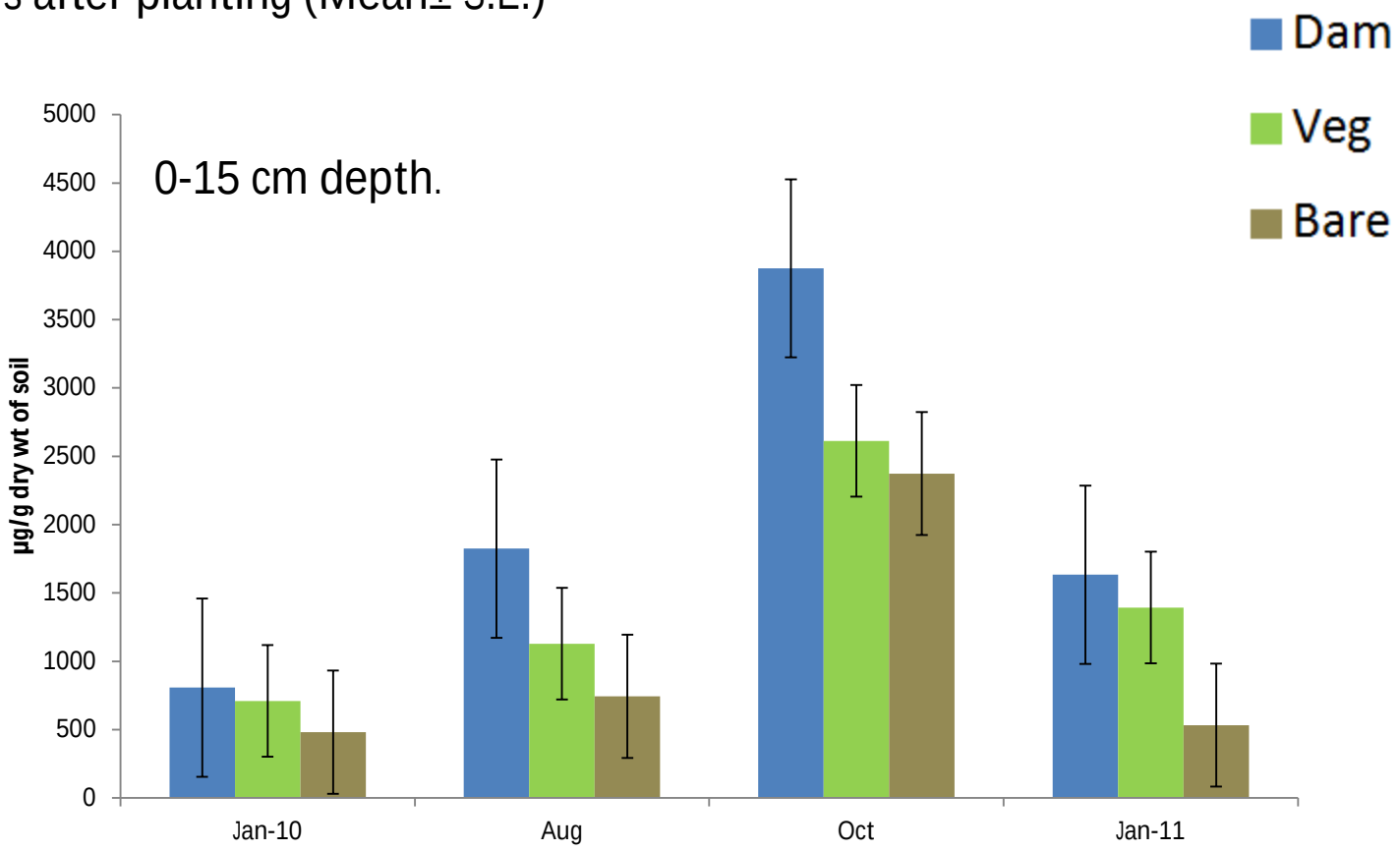




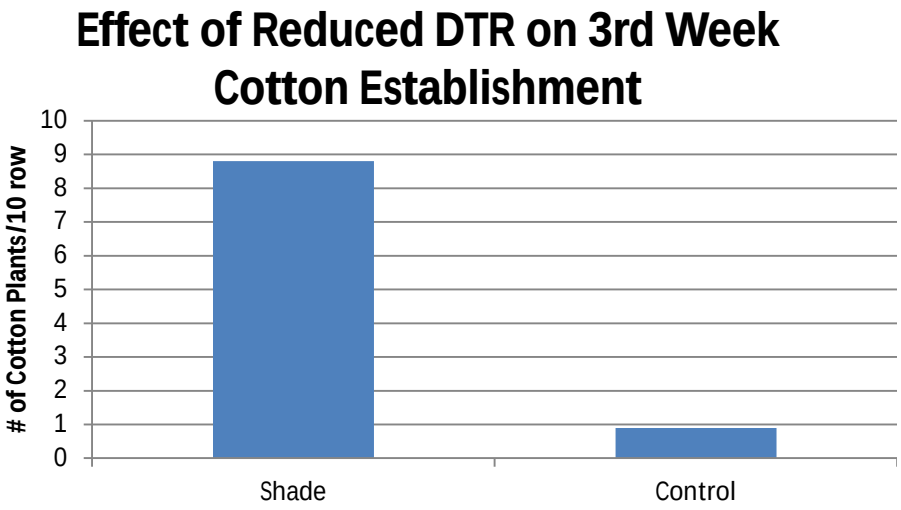
4 yrs after planting
Mean± S.E.

Microbial Biomass: North Rosillos Site

- 4 yrs after planting (Mean± S.E.)



Impacts of DTR_{soil} in Agriculture



No Chicken Little Here!

- **Section 6**

Challenges for the South Central Region

- Ecosystem restoration under increased climate variability.
- Fish and wildlife response to climate change?
- Invasive species and fires
- Protection of trust species
- Wildlife diseases
- Climate impacts on agriculture
- Renewable resources - water

What Can We DO!

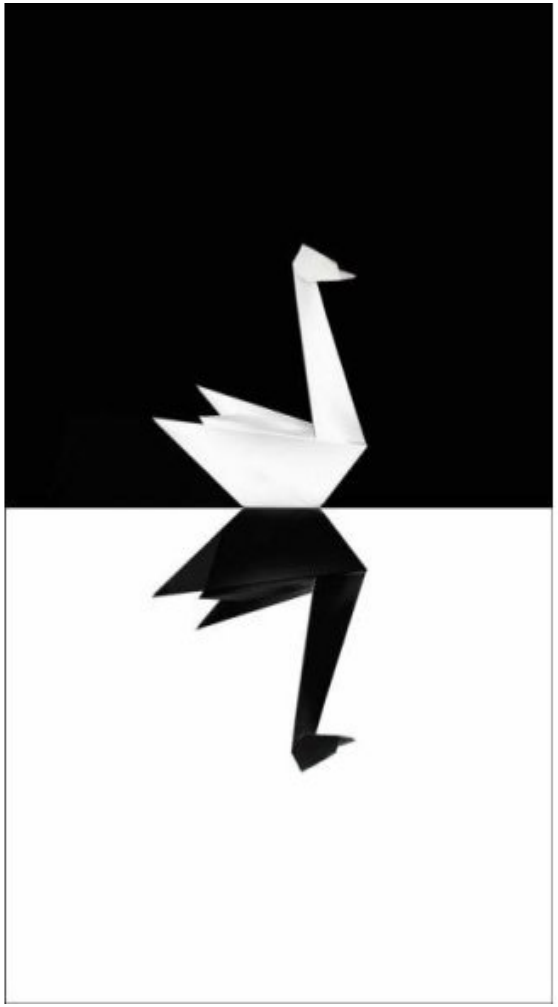
- Be aware of Unintended Consequences

- The Black Swan Events

(The Impact of the Highly Improbable) – epistemologist Nassim Nicholas Taleb.

- Take advantage of the White Swans

- Avoid creating the Black Swans



What are the Challenges for Texas & the South Central Region

- What have been the historical patterns of drought, how have drought patterns changed over the past century and what are current implications to natural and human systems?

What are the Challenges for Texas & the South Central Region

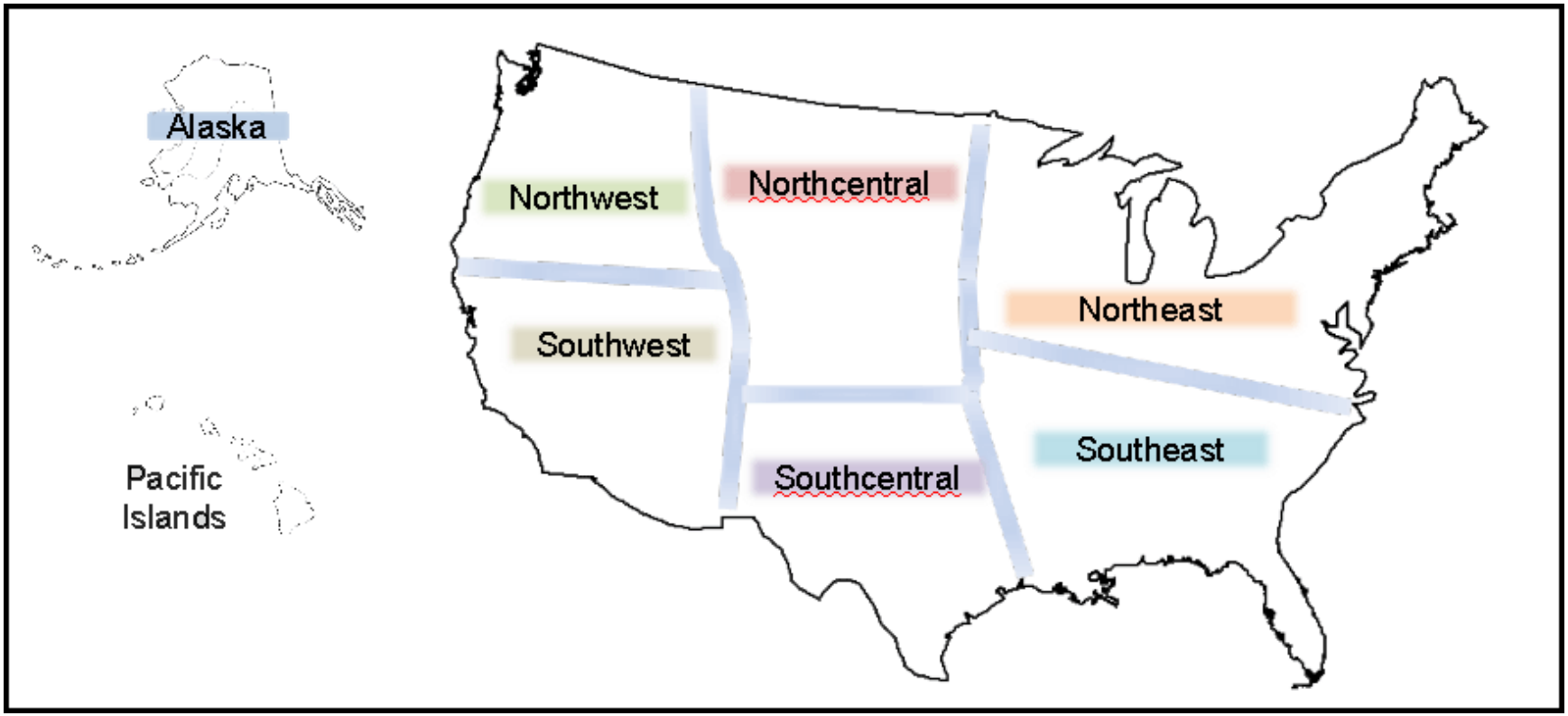
- With increasing climate variability across the south central region, what types of extreme weather events are more or less likely to occur and what will be the future periodicity of these events?

What are the Challenges for Texas & the South Central Region

- What information do we need to facilitate structured decision making and determination of thresholds when addressing sustainability of ecological systems?

Addressing Climate Change and Climate Variability

SOUTH CENTRAL
CLIMATE SCIENCE CENTER



Thank You!