Understanding Ecological Responses To Climate Variability Across a Big State

or

Why Does Everything in Texas Have to be Big!

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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!
“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
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)
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

1990 Map

2006 Map

After USDA Plant Hardiness Zone Map, USDA Miscellaneous Publication No. 1475, Issued January 1990

National Arbor Day Foundation Plant Hardiness Zone Map published in 2006.

Zone

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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
• 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

1990 Map

2006 Map


National Arbor Day Foundation Plant Hardiness Zone Map published in 2006.

Zone

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Edwards Plateau Precipitation Variability
Edwards Plateau Average Yearly Temperature Variability
Current Drought Status

U.S. Drought Monitor

October 15, 2013
(Released Thursday, Oct. 17, 2013)
Valid 7 a.m. EDT

Drought Impact Types:
- D0 Abnormally Dry
- D1 Moderate Drought
- D2 Severe Drought
- D3 Extreme Drought
- D4 Exceptional Drought

Author:
Richard Tinker
CPC/NOAA/NWS/NCEP

http://droughtmonitor.unl.edu/
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

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).
Decreases in surface water
Variability of Precipitation

20-year mesic interval:
Wetter than previous wet periods and as wet as previous drought periods were dry.
How Small Scale Can Influence Everything

- Section 5

Big Bend NP
Changing Precipitation Patterns: BBNP

Panther Junction Summer Average IP

Panther Junction Winter Average IP
Soil Microbial Responses to Precipitation Changes: BBNP
What Controls the Functioning of Arid Systems?
Modifying DTR soil at BBNP
Understanding DTRsoil

- **Exposed soils**
- **Shaded soils**

**Daytime cooling**
- **Nighttime warming**

**Change in cooling curve**
Effects of DTR\textsubscript{soil} on Microbial Activity
(van Gestel)
Grassland Restoration and $DTR_{soil}$
**No₃ Dynamics: North Rosillos Site**

### A.

**0-15 cm**

<table>
<thead>
<tr>
<th>Sample Date</th>
<th>Mean ± S.E.</th>
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<tbody>
<tr>
<td>Jan-10</td>
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<tr>
<td>Aug</td>
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<tr>
<td>Oct</td>
<td></td>
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<tr>
<td>Jan-11</td>
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</tbody>
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### C.

**15-30 cm**

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<th>Sample Date</th>
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</table>

4 yrs after planting
Mean ± S.E.
• 4 yrs after planting (Mean± S.E.)

0-15 cm depth.
Impacts of $DTR_{soil}$ in Agriculture

Effect of Reduced DTR on 3rd Week Cotton Establishment

- **Shade**: 10 Cotton Plants/10 row
- **Control**: 0 Cotton Plants/10 row
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

[Map of the United States with regions labeled: Northwest, Northcentral, Northeast, Southwest, Southcentral, Southeast, and Alaska, along with the Pacific Islands.]
Thank You!