


Climate Change Adaptation, Natural Resource Management

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Great Plains Riparian, September 9, 2008


Weather versus Climate

- **Weather – state of the atmosphere now**

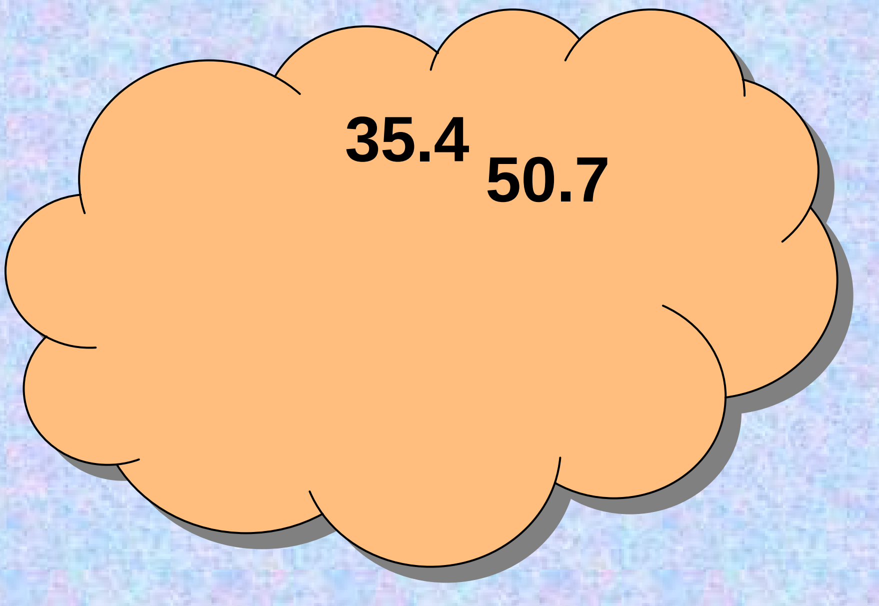
- **Climate - mean and variability of weather over a period of time in a particular geographic region**

Weather versus Climate

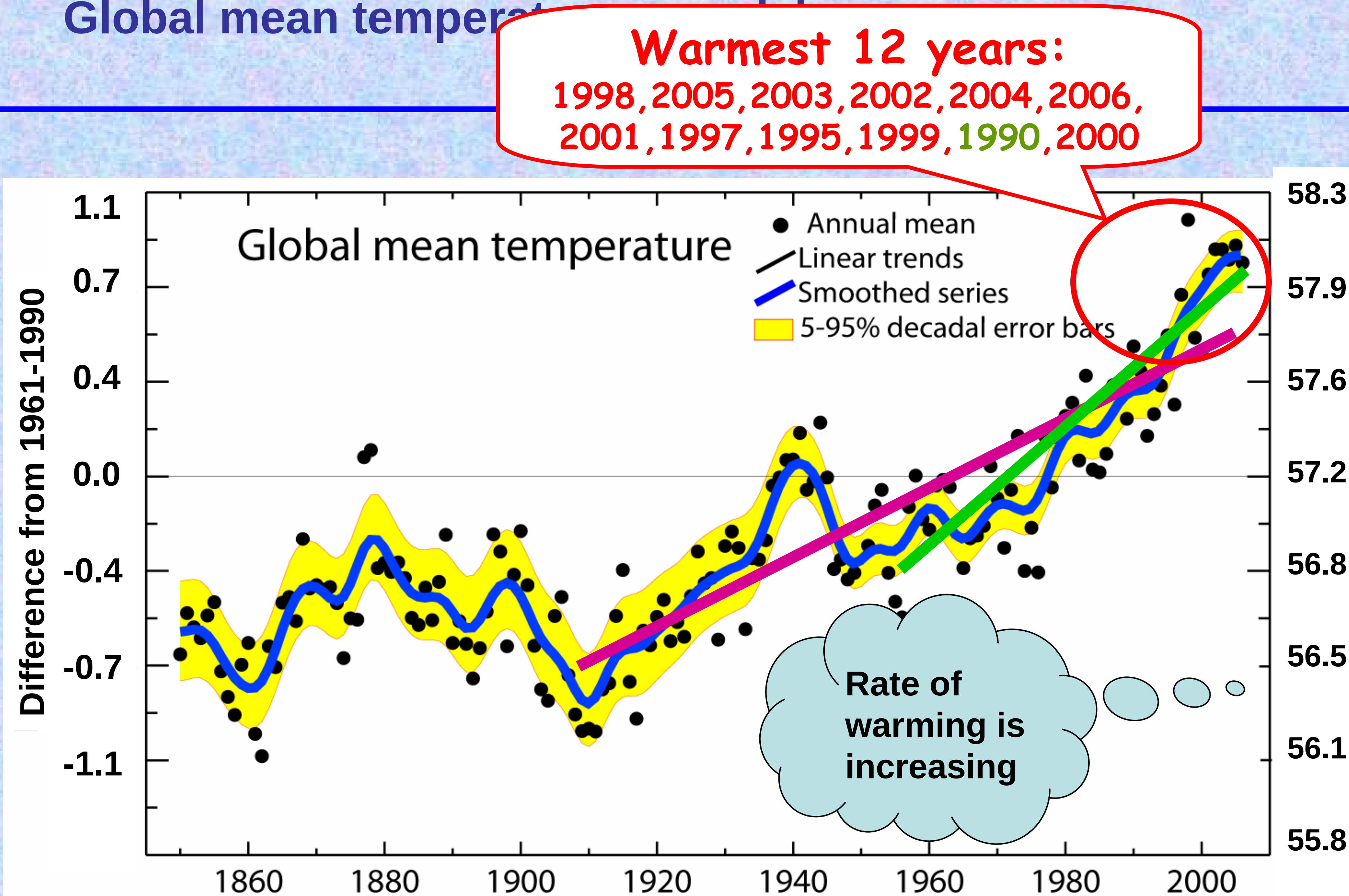
Climate is an ‘envelop of possibilities’ within which the Weather bounces around

Sioux Falls Climate -- 1948-2008

Monthly Temperature = 45.7 degrees F



Global mean temperat



IPCC WG1 2007

Frost-Free Days Are Increasing

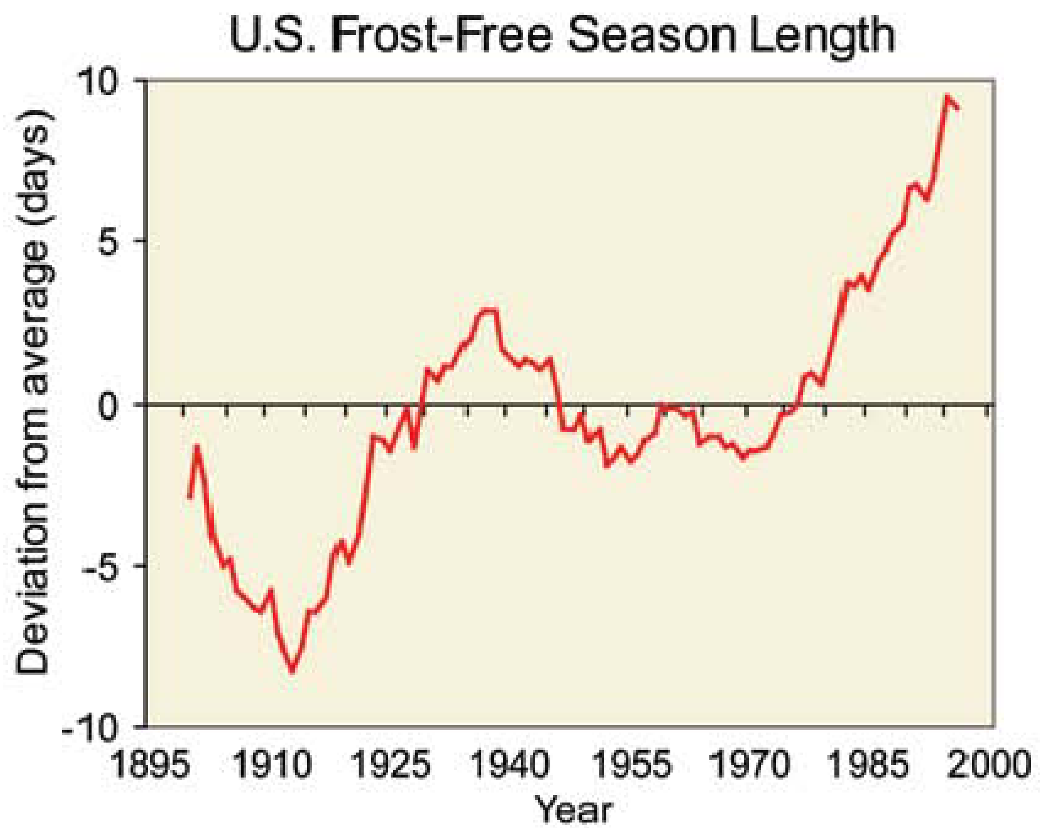
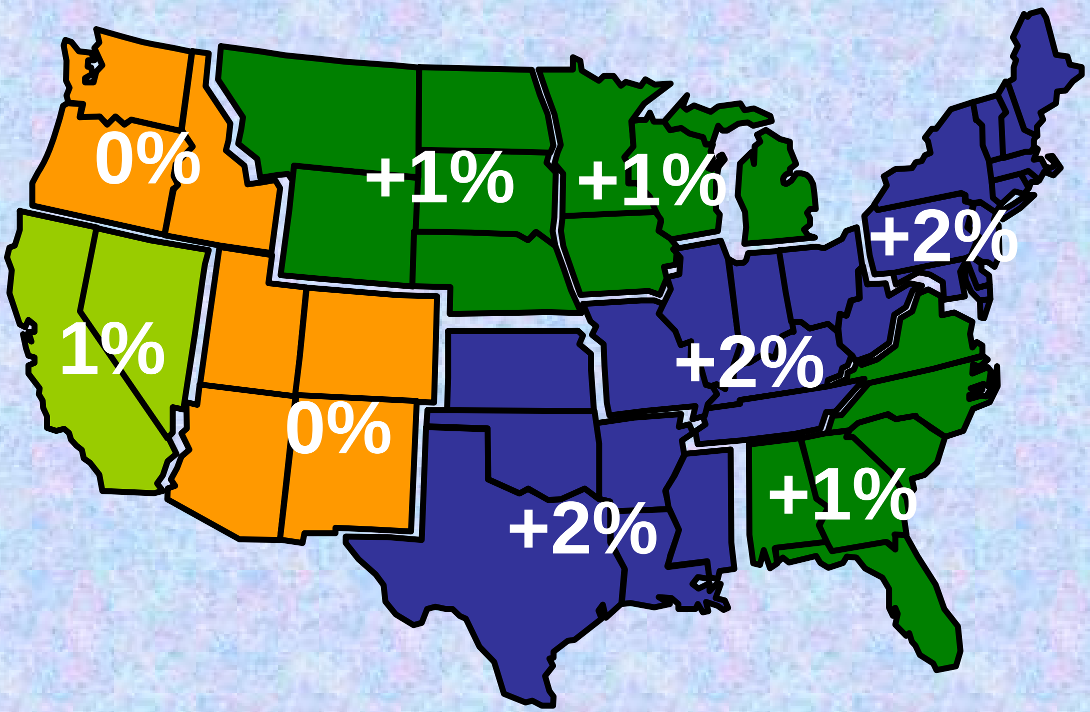


Figure 2.4 Change in the length of the frost-free season averaged over the United States (from Kunkel *et al.*, 2003). The frost-free season is at least ten days longer on average than the long-term average.

Synthesis and Assessment Report 3.3 Weather and climate extremes in a changing climate

Precipitation Patterns Are Changing

More precipitation from intense downpours



Trends in proportion of annual precipitation of extreme intensity (> 2” per day): 1910 – 1995

Karl & Knight 1998

Phenological Changes

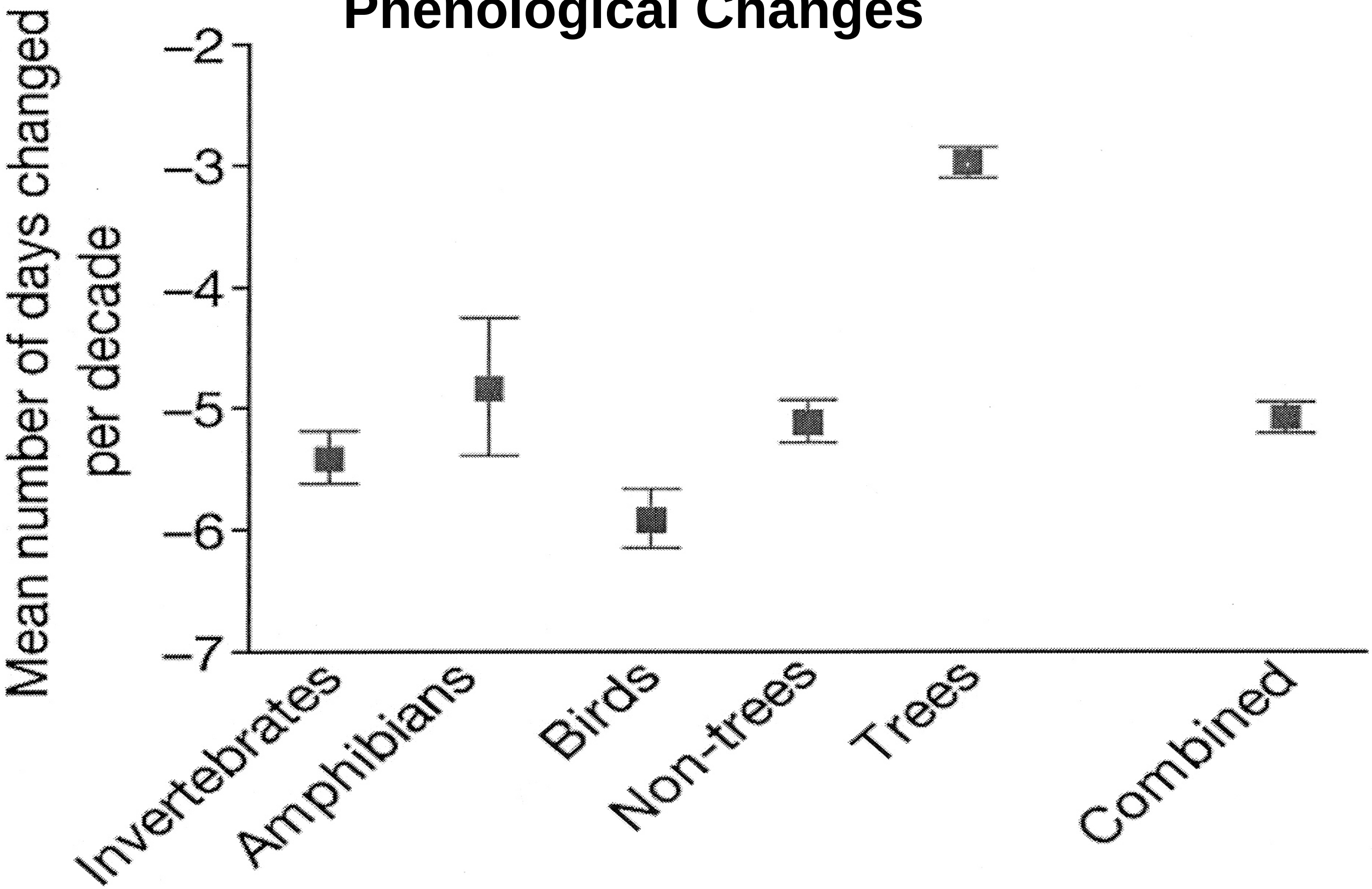
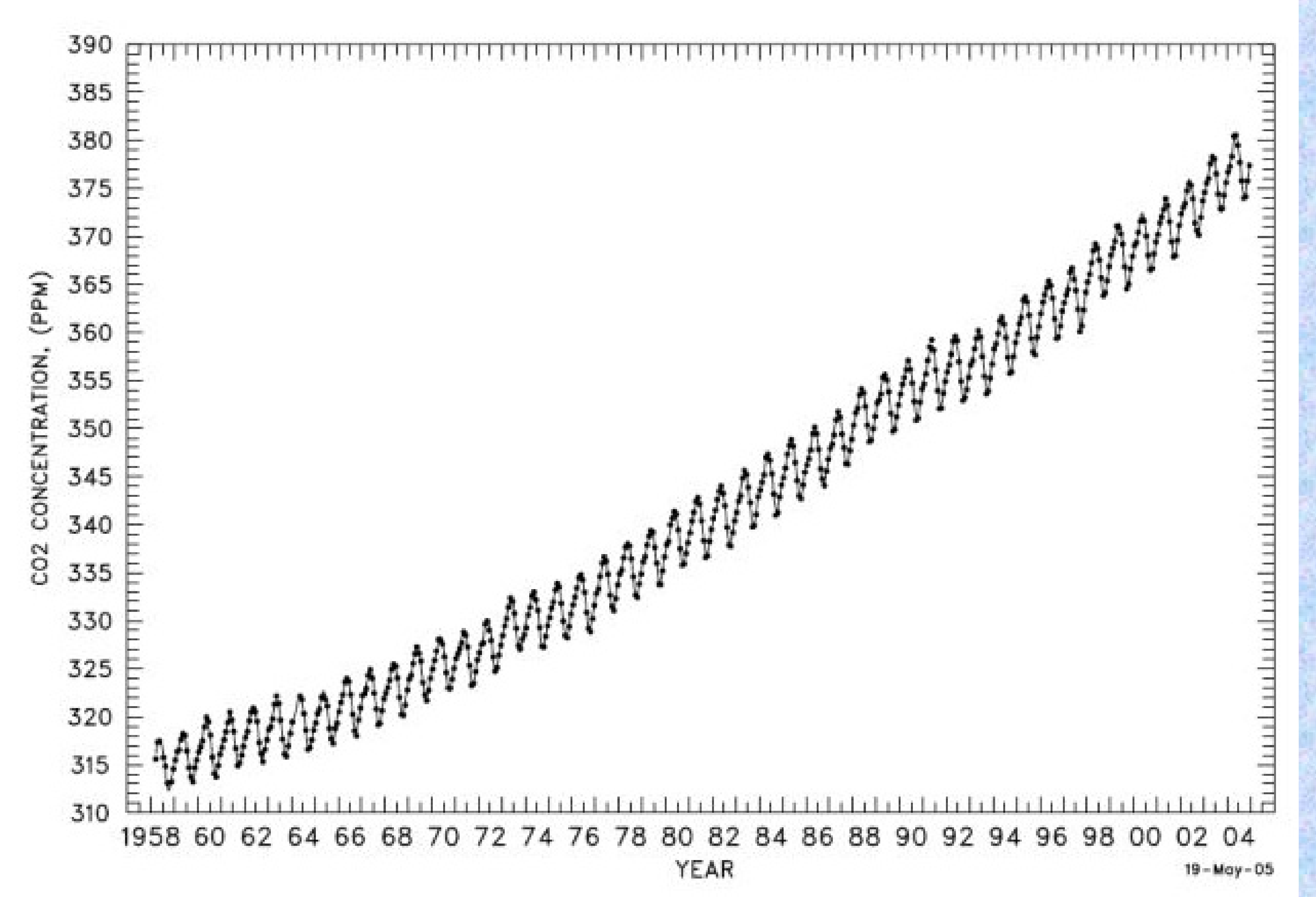


Figure 2 Means ± s.e.m. of days changed for the given groups of species. The 'Combined' category includes only those species tallied in the groups of species (that is, data for the one mammal, two fish and zooplankton are not included).

Atmospheric Concentrations of Carbon Dioxide – Mauna Loa, Hawaii



Plant Response to Elevated CO_2

Field and Laboratory Studies suggest that Invasive Species

Respond to elevated carbon dioxide

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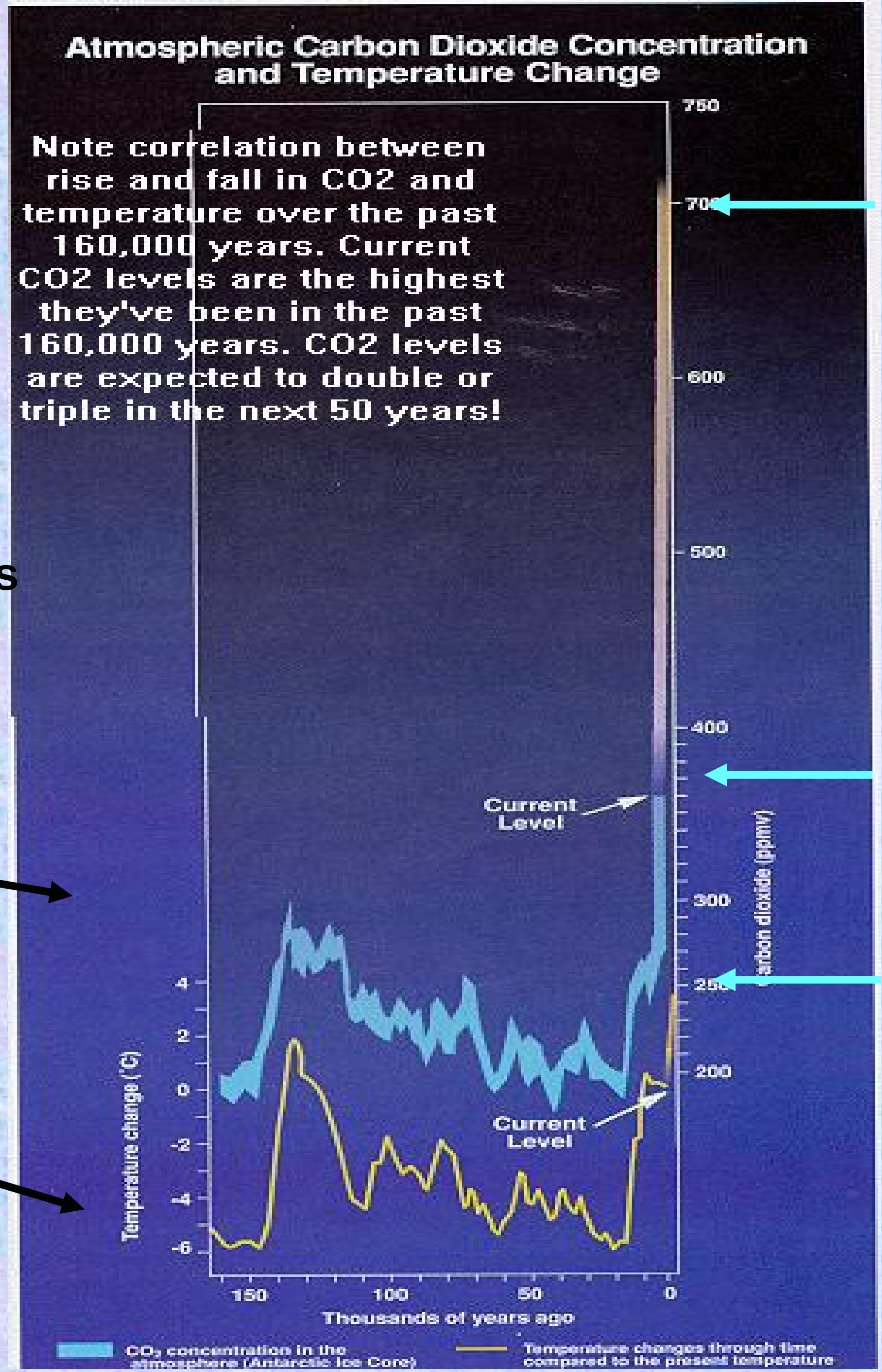
Atmospheric CO_2 Concentrations

Last 150,000 years

Atmospheric CO_2

Temperature



700+ ppm (projected within 100 years)

With 4 to 10 degree F increase in temperatures

380 ppm (current)

280 ppm

(pre-industrial)

Source: US EPA http://www.epa.gov/reg3artd/globclimate/600kyrs.htm

Exploring the Future with Climate Scenarios and Ecological Models

Soil moisture declines over next 100 years

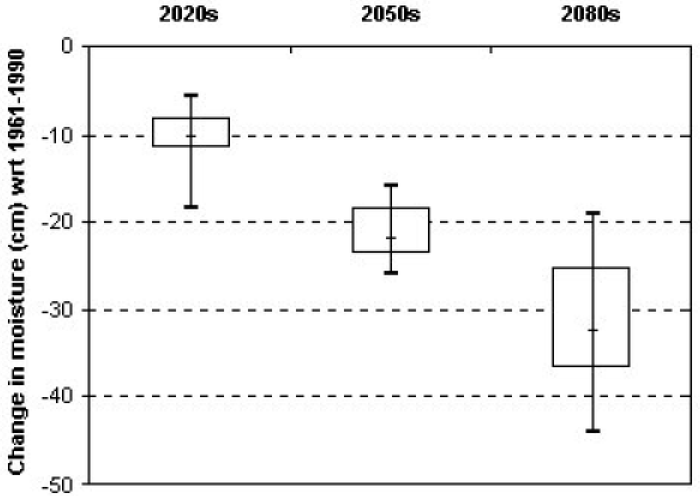
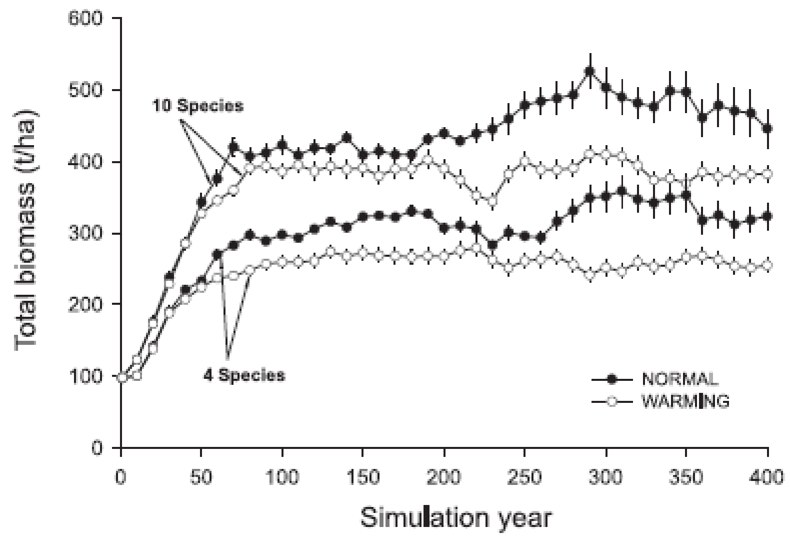


Figure 5: Summary of the projected changes in soil moisture levels (averaged over the five island forest study sites) for the 2020s, 2050s and 2080s. The thin vertical lines in the plot indicate the range of possible future moisture levels compared with the climate of 1961-1990.

Henderson et al 2002

Total biomass declines under warming

Fig. 2. Temporal variation of aboveground tree biomass in the simulated forests with 10 and 4 species under both normal and projected warming climates (forest width = 10 m). Vertical bars indicate the spatial variation (SE) of aboveground biomass among simulated plots (paired Student's t tests on SE of tree biomass across plots, $P < 0.0001$).



Climate Change Impacts to Riparian Ecosystems

- Greater depletion of water
- Exotics will likely expand
- Increases in water erosion from uplands
- And thus, delivery of nutrient-rich sediment to riparian areas.
- Increased re-structuring of riverine corridors

Riparian Area Functions

1. Store water and help reduce floods;
2. Stabilize stream banks and improve water quality by trapping sediment and nutrients;
3. Shade streams and help maintain temperature for fish habitat;
4. Provide shelter and food for birds and other animals;
5. Support productive forests which can be periodically harvested;
6. Can be used as recreational sites
7. Provide productive pasture lands for livestock.

Oklahoma State Extension Service NREM-5034

Adaptation to Climate Change

Takes place through adjustments

to reduce vulnerability or to enhance resilience

in response to observed or expected changes in climate and associated extreme weather events

new jersey njdep department of environmental protection

Land acquisition program

Confederation Bridge, Canada
Constructed 1 metre higher to account for climate change

Increased use of artificial snow by Alpine ski industry

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Planning and Managing for Climate Change

- **Information for Adaptation**
  - **Assessing <u>vulnerability</u>**
    - How might this be explored?
  - **<u>Adaptive Capacity</u>**
    - What influences this?
- **Management Strategies**
  - **Reactive and Anticipatory Adaptation**
  - **Reflections on Past Experiences**

Criteria to Identify Vulnerabilities to Climate Change

- Magnitude of Impact
- Timing
- Persistence or Reversibility
- Likelihood of Impacts
- Capacity for Adaptation
- Distribution of Impacts: social, geographic
- Importance: ecological, social, economic

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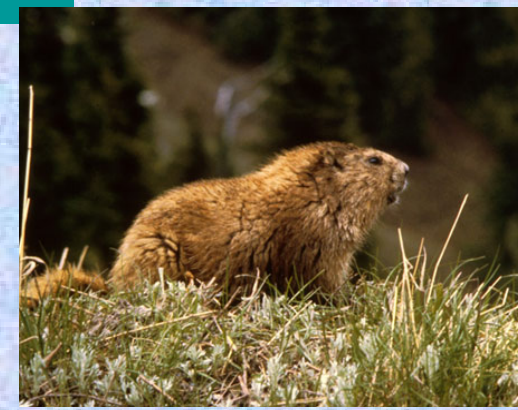
Data to Identify Vulnerabilities

Timing – sudden versus gradual

Breashers et al 2007



National Geographic

GRADUAL CHANGE
Average snowmelt date has not shifted. Marmots emerging 3 weeks earlier from hibernation than a few decades ago. Still snow covered fields on their emergence date.

Inouye et al 2000

Data to Identify Vulnerabilities

Persistence and reversibility of impacts

When does ‘drought’ become ‘climate’?

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ADAPTATION

	Anticipatory	Reactive

ADAPTATION: REACTIVE, ANTICIPATORY

		Anticipatory	Reactive
Natural Systems			• Changes in length of growing season • Changes in ecosystem composition • Wetland migration
Human Systems	*Private*	• Purchase of insurance • Construction of house on stilts • Redesign of oil-rigs	• Changes in farm practices • Changes in insurance premiums • Purchase of air-conditioning
	Public	• Early-warning systems • New building codes, design standards • Incentives for relocation	• Compensatory payments, subsidies • Enforcement of building codes • Beach nourishment

Capacity for Adaptation: Humans

- **Adaptive Capacity in human systems is influenced by local factors:**
  - Available and appropriate skills
  - Available financial resources
  - Local support: family, stakeholder, etc.
- **General factors: Socioeconomic and political**
  - Federal laws
  - Federal policies and regulations
  - Globalization of markets
  - Commodity market conditions

Confronting Climate Change

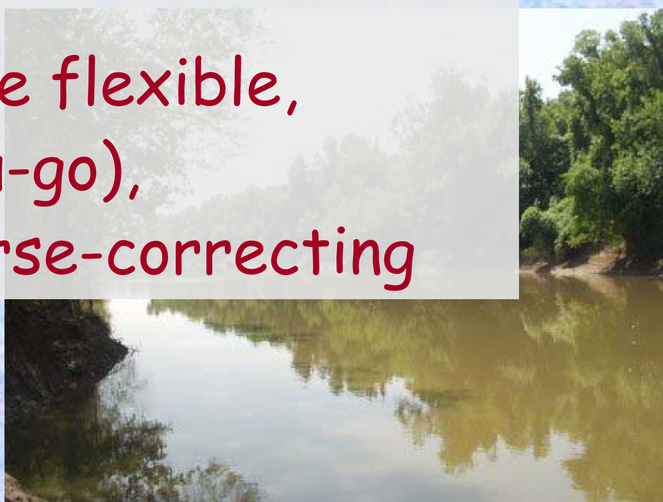
Planning and Management Decisions

BUILDING THE TOOLBOX

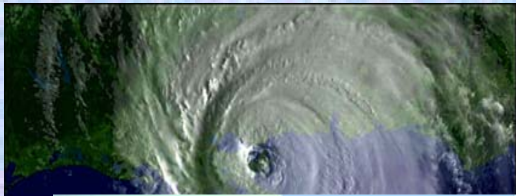
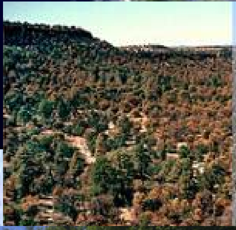
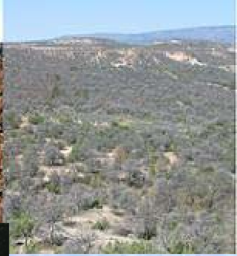
- No single solution fits all
- Options for short term – forestall impacts

  Building in resistance and resilience
- Options for long term – manage for change

  Enable change and transitions
- Mix and match tools
- Capitalize on experience, Be flexible, experimental (learn-as-you-go), innovative, risk-taking, course-correcting

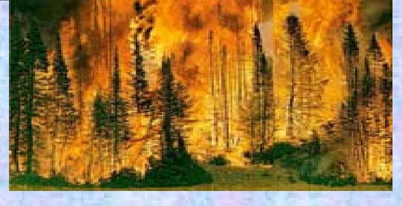


‘Win-Win’ Strategy – Address Current Stressors

- Altered Disturbances
  - Drought, fire, insects
- Habitat Fragmentation and Habitat Loss

- Invasive Plants, Animals, and Pathogens



- Air and Water Pollution
- Legacy of Past Management

Reflection of Experiences as Resource Managers

- Have you ever experienced a weather-related event where you had to change your management actions and maybe goals?
- What type of information was needed?
- **What would you do differently?**

drought

- Setting – National Forest, City watershed on the National Forest,
- Focus – Weather suggesting drought
- In place – Agreement on how forest and water management would be affected by the drought

Realization – ‘Drought’ was not defined

Reflection of Past Experiences

One Point in Time
Unusual Event
Perhaps no long-term change
in resource management actions

Valuable Experience

IPCC http://www.ipcc.ch

FS Climate Change Resource Center

http://www.fs.fed.us/ccrc

Synthesis and Assessment Report 4.4 'Preliminary Review of Adaptation Options for Climate-sensitive Resources and Ecosystems'

http://www.climatescience.gov/Library/sap/sap4-4/final-report/

Synthesis and Assessment Report 4.3 'The Effects of Climate on Agriculture, Land Resources, Water Resources, and Biodiversity'

http://www.climatescience.gov/Library/sap/sap4-3/final-report/

Colorado State University Scott Denning 'Tiny Molecules'

http://changingclimates.colostate.edu/

Photo credits: USFS Region 3, Kansas State Forest Service, Linda Joyce, John Frank