Planning to Protect:
How to be more ready in a changing climate

LA Sea Grant Workshop with Lafourche
January 10, 2013

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Southern Climate Impacts Planning Program, LSU

Key Messages

1. Climate change is here. We are already observing changes. (Big Picture – WHY you might care)

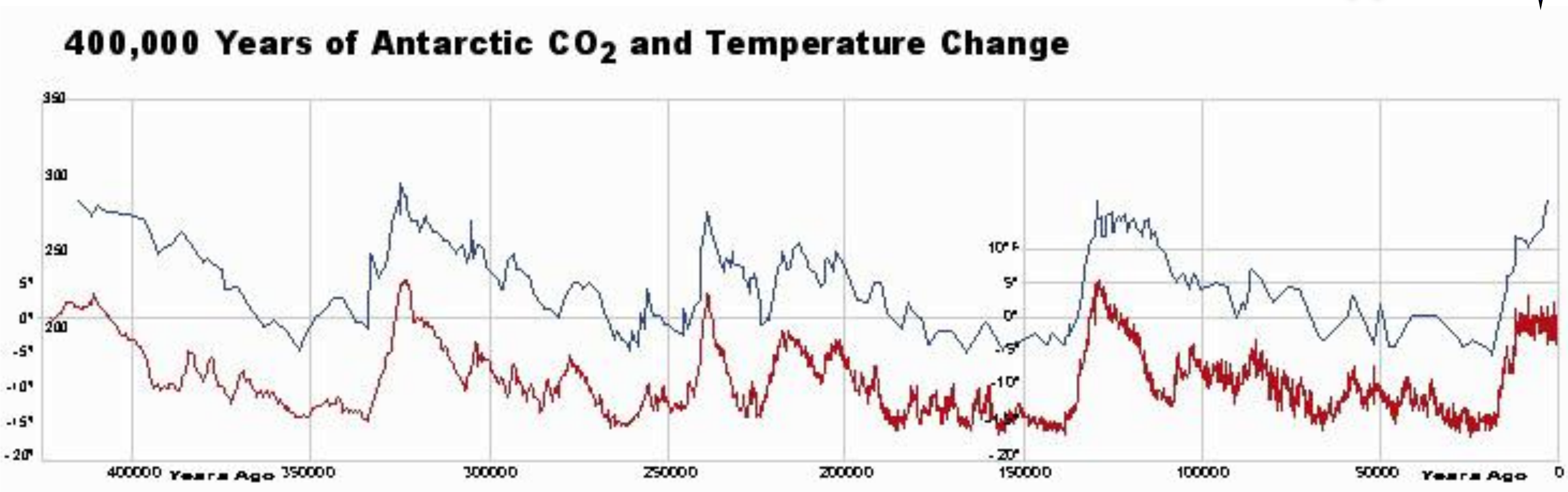
1. The future will be different than the past and there will be consequences for the region. (WHAT – local impacts)

1. Decisions made today can help us to be better prepared for tomorrow. (HOW – local decisions)

Past 400,000 Years

CO_2 and Temperature

390 ppm



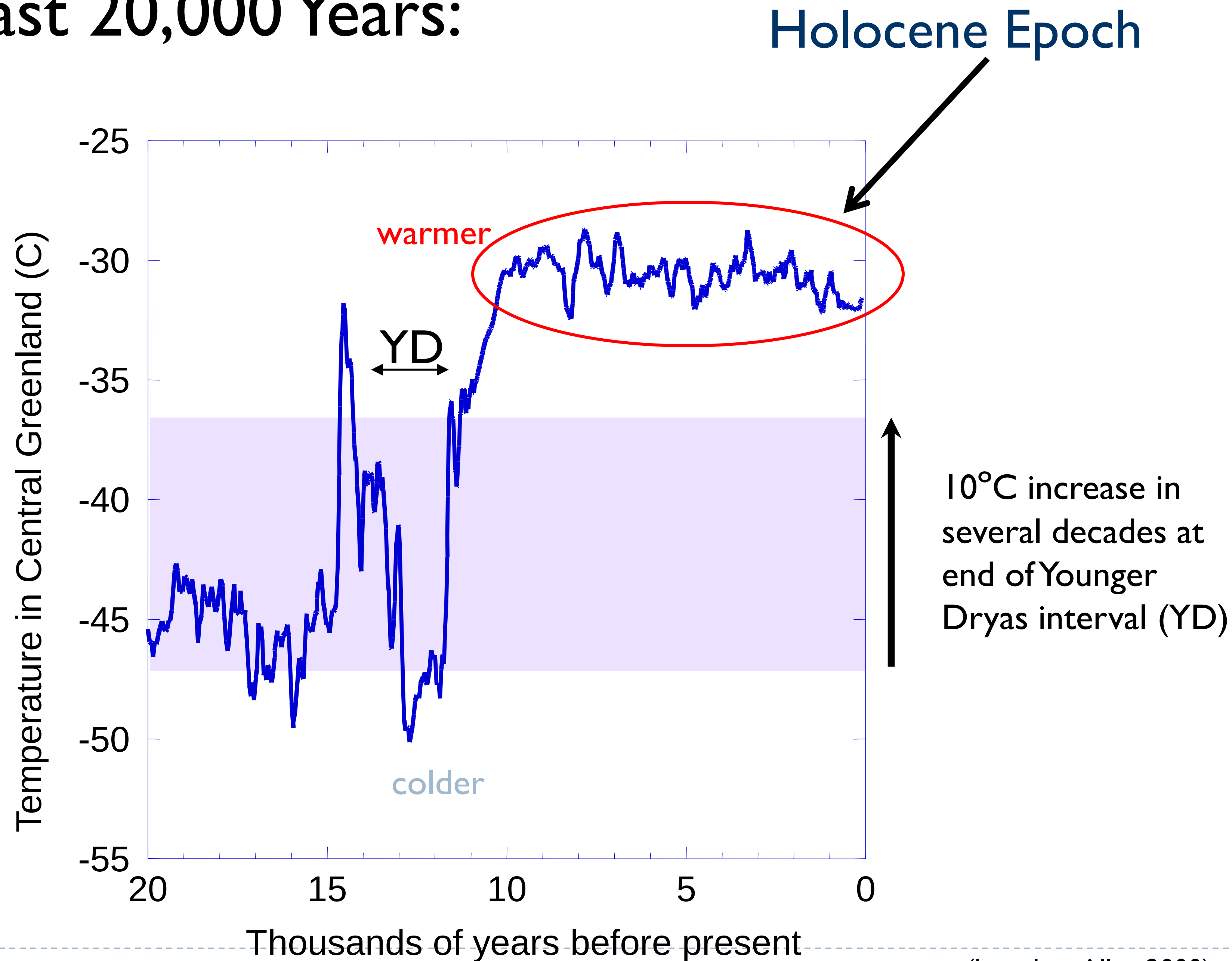
Upper, blue line = C02 level

Lower, red line = temperature

Record from Vostok, Antarctica ice core project

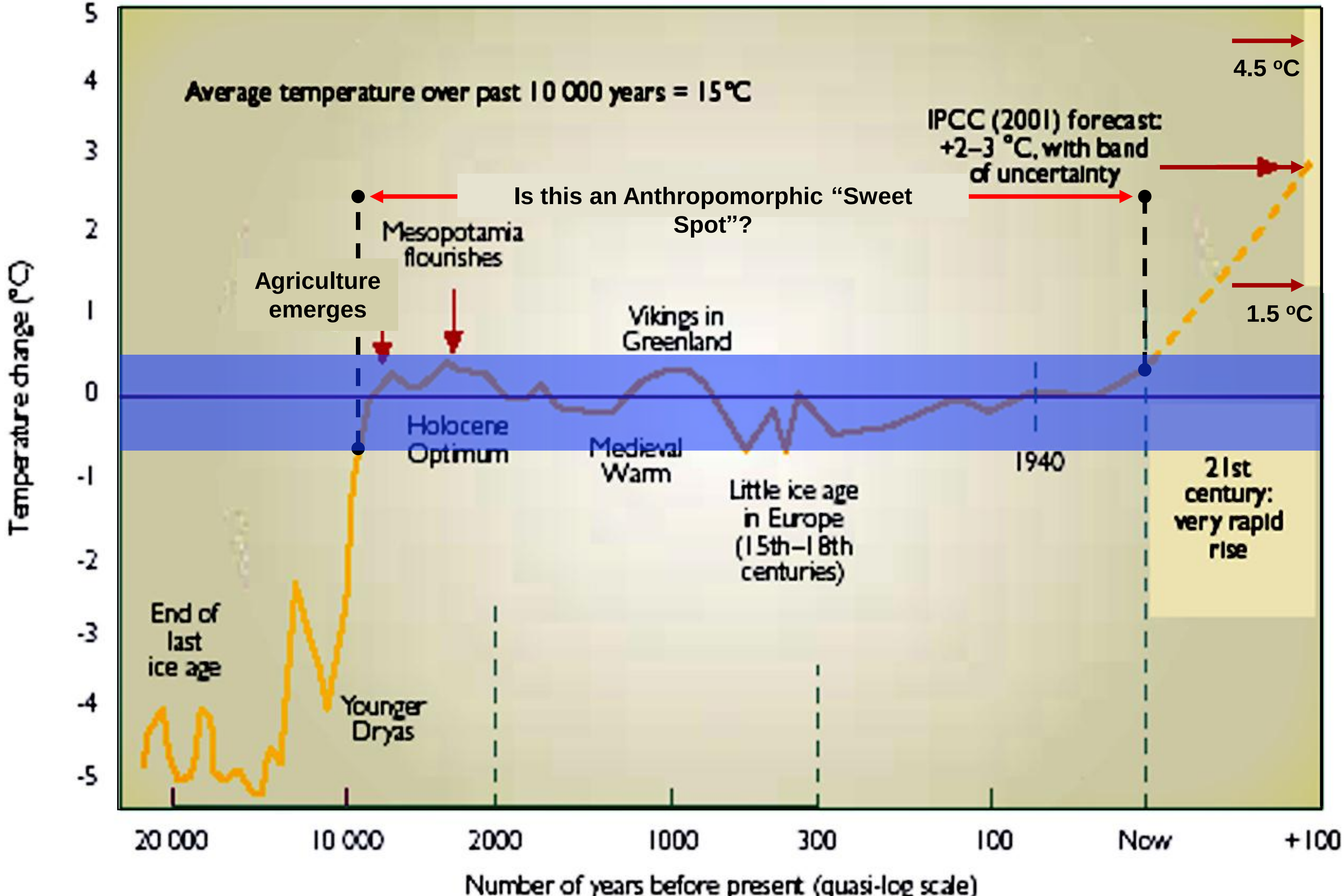
(Petit *et al*. 1999)

Past 20,000 Years:



(based on Alley, 2000)

The Last 10,000 Years seems to have been Ideal for the Development of Human Societies. Is this a Historic "Sweet Spot" that Enabled Humans to Flourish?



Slide from: Bob Corell

Louisiana is NOT the canary in the coal mine!

From: Gary McManus

Key Messages

1. Climate change is here. We are already observing changes. Changes are happening at an increasingly rapid rate and . . . a rate beyond historical experience. (Big Picture – WHY you might care)

1. The future will be different than the past and there will be consequences for the region. (WHAT – local impacts)

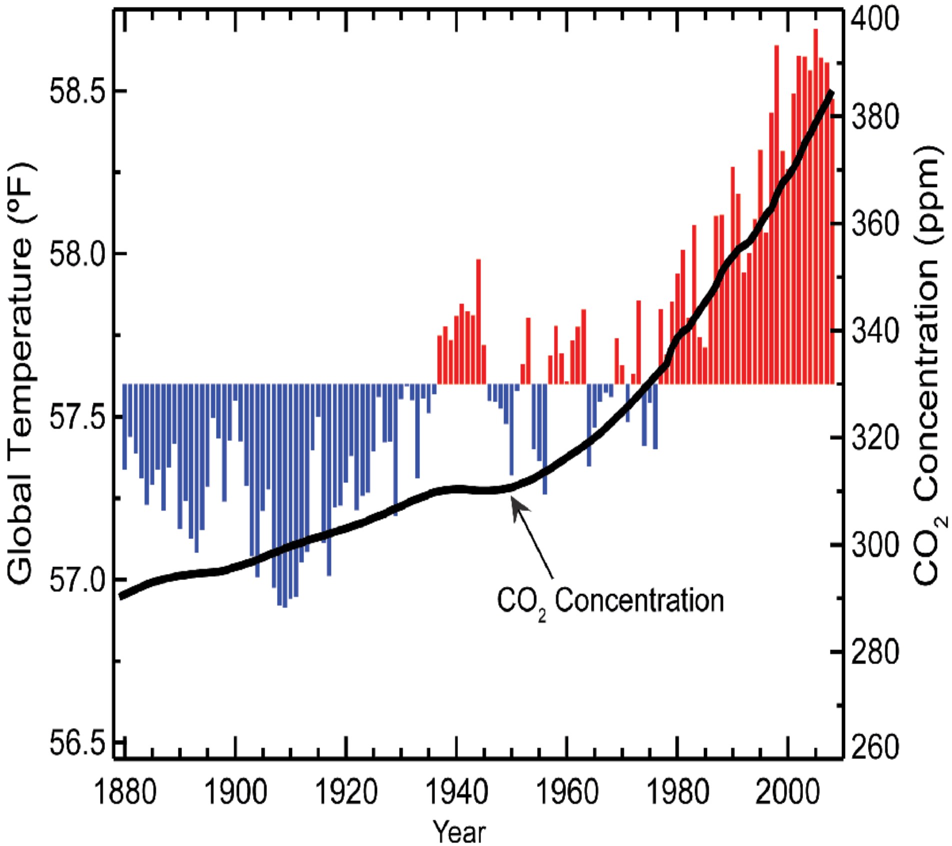
1. Decisions made today can help us to be better prepared for tomorrow. (HOW – local decisions)

Changes Observed in Many Areas

The climate is already changing.

Can be seen in many records:

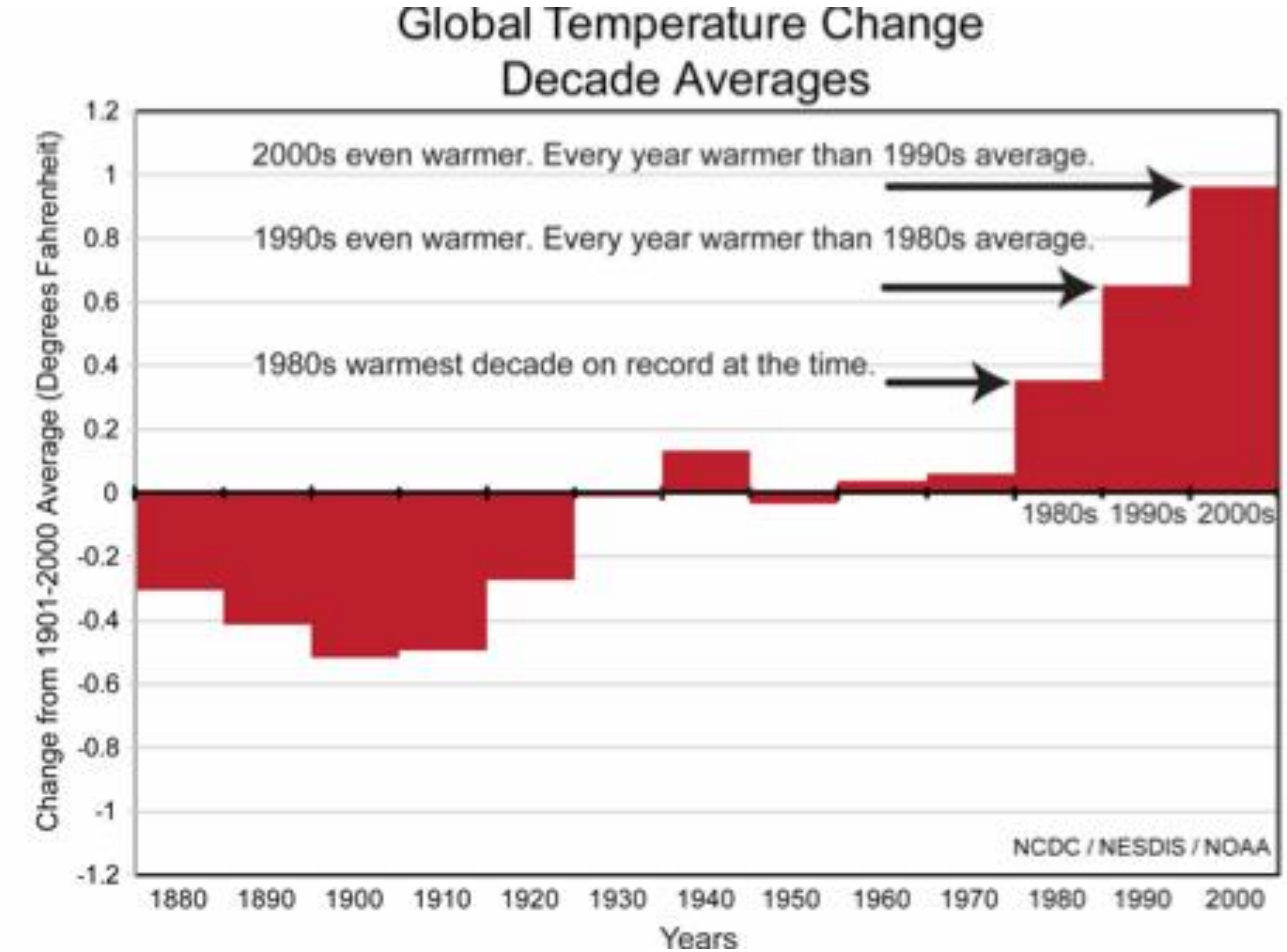
- increases in global-average surface and air temps
- widespread melting of snow and ice
- rising sea levels
- changes in precipitation patterns
- northward moving hardiness zones
- northward moving animals



Global Annual Average Temperature: land and ocean and CO2 concentration

from: Global Climate Impacts on the US

Decades – progressively warmer



State of the Climate, 2009

Changes Observed: Temperature

- Average US temperature over 50 years increased more than + 2 ˚F (some locations more and others less than average)

- More frequent days above 90˚F

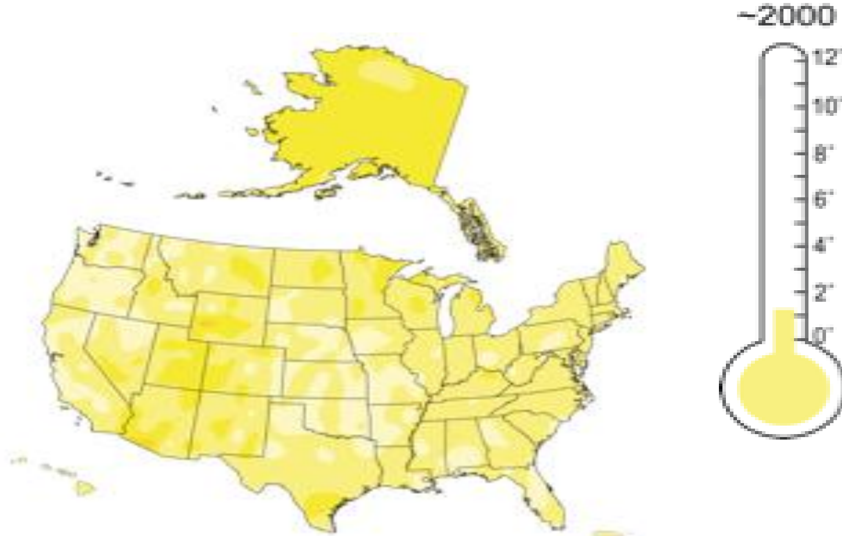
- Increased frequency and intensity of heat waves and regional drought

Present-Day (1993-2008)
Average Change
from 1961-1979 Baseline

From: Global Climate Change Impacts
In the US, 2009 pg 28

Local Changes to Temperature

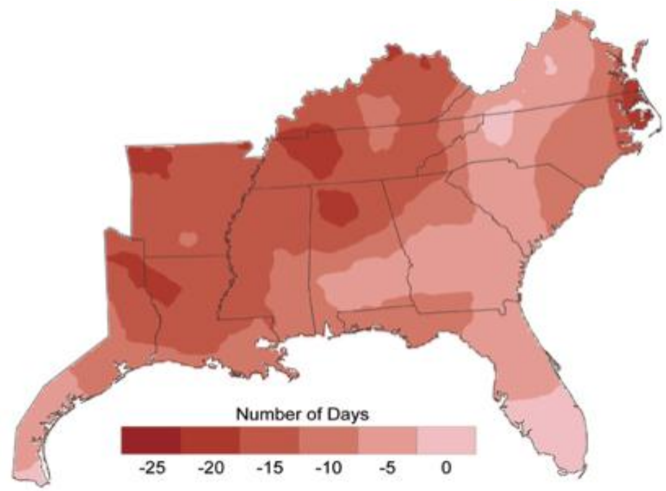
Present-Day (1993-2008) Average Change from 1961-1979 Baseline
Change in Freezing days per year: since mid 1970s



- This region: temp declined from 1901 to 1970

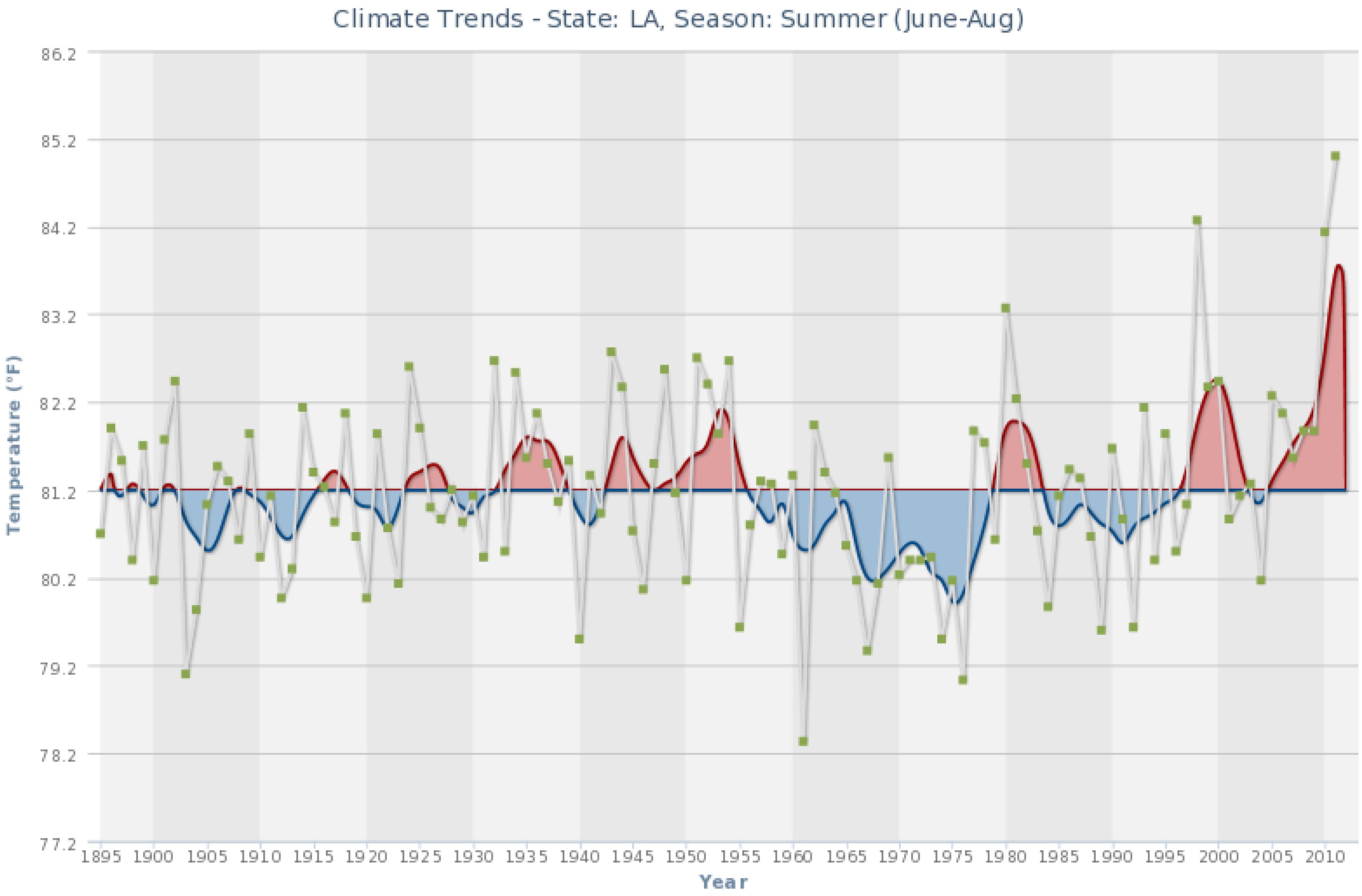
- Since 1970 average SE temps increased + 1.6˚F and winter temps up + 2.7˚F

- Freezing days have declined by 4-7 days/yr for most of the region since mid-1970s: 20 fewer west LA; 5 fewer mid FL



From: Global Climate Change Impacts in the US, 2009, pgs 28, 112

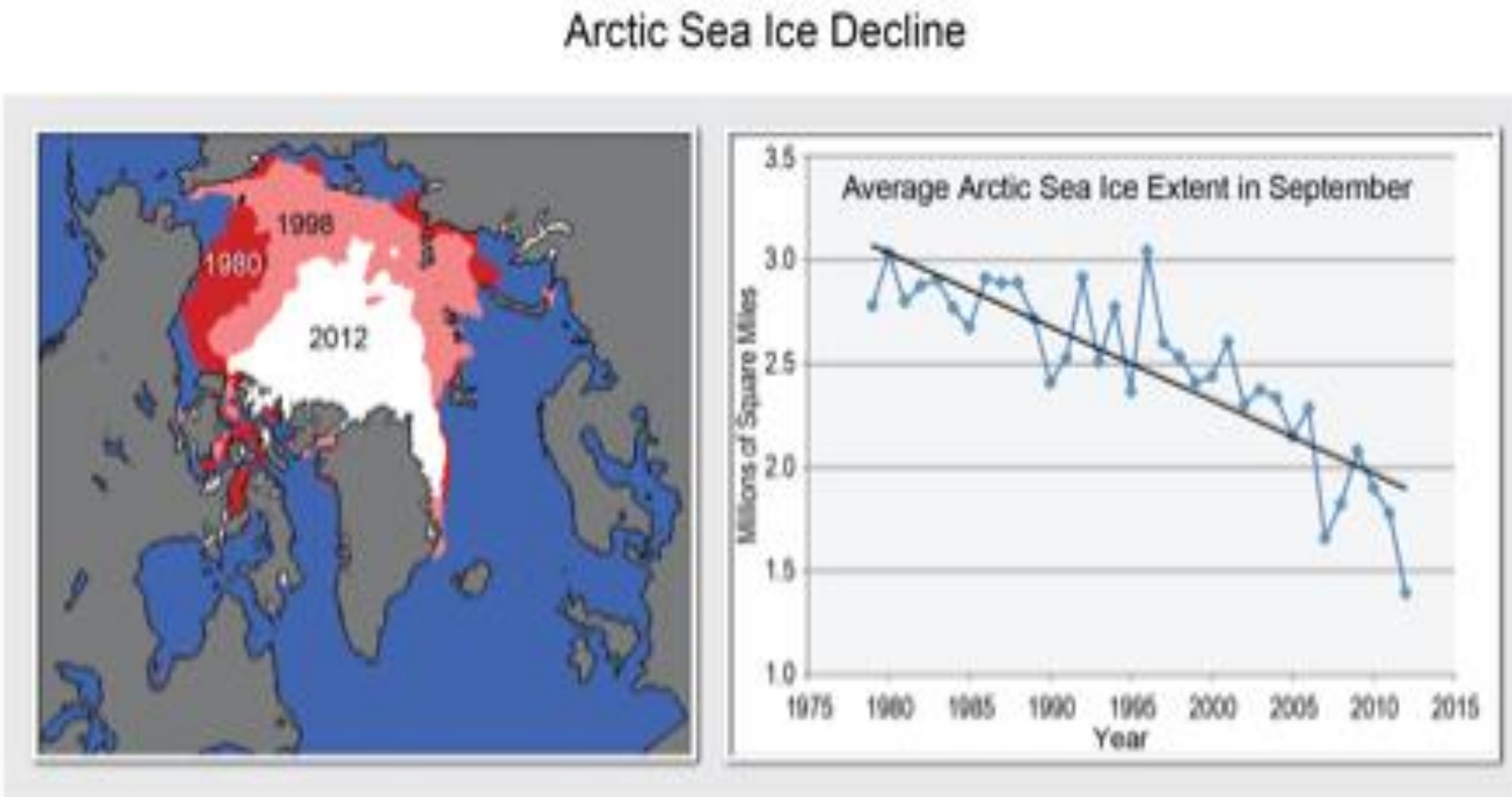
Louisiana Temperature: 1895-2010



From: southernclimate.org


Positive proof of global warming.
18th
entury
1900
1950
1970
1980
1990
2006
Hollywood
2010

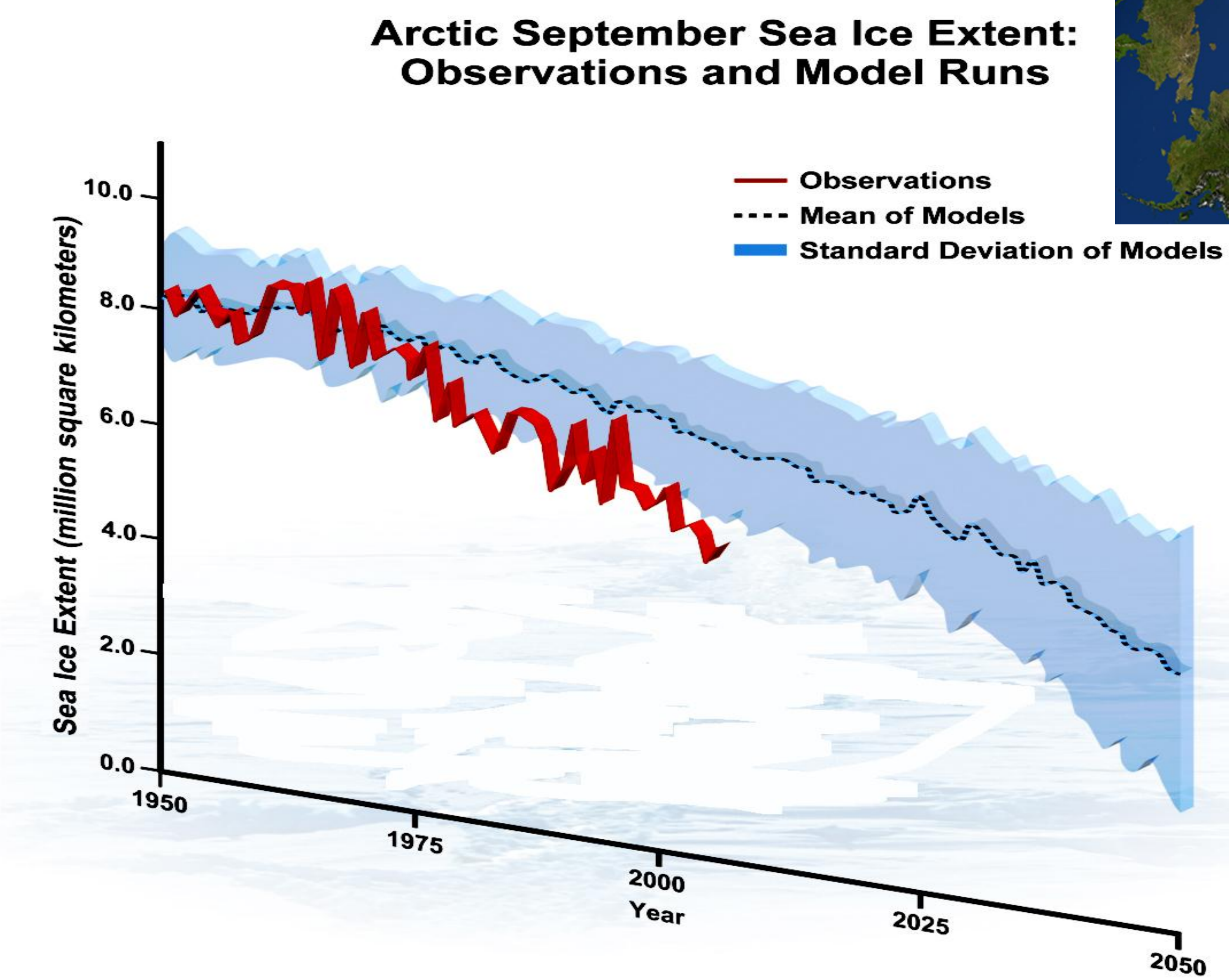
Arctic Sea-Ice Extent: Annual Average



White areas 40% below average for 1979-2000, also thinner.
Annual variations in September Arctic Sea Ice extent for 1979-2012.

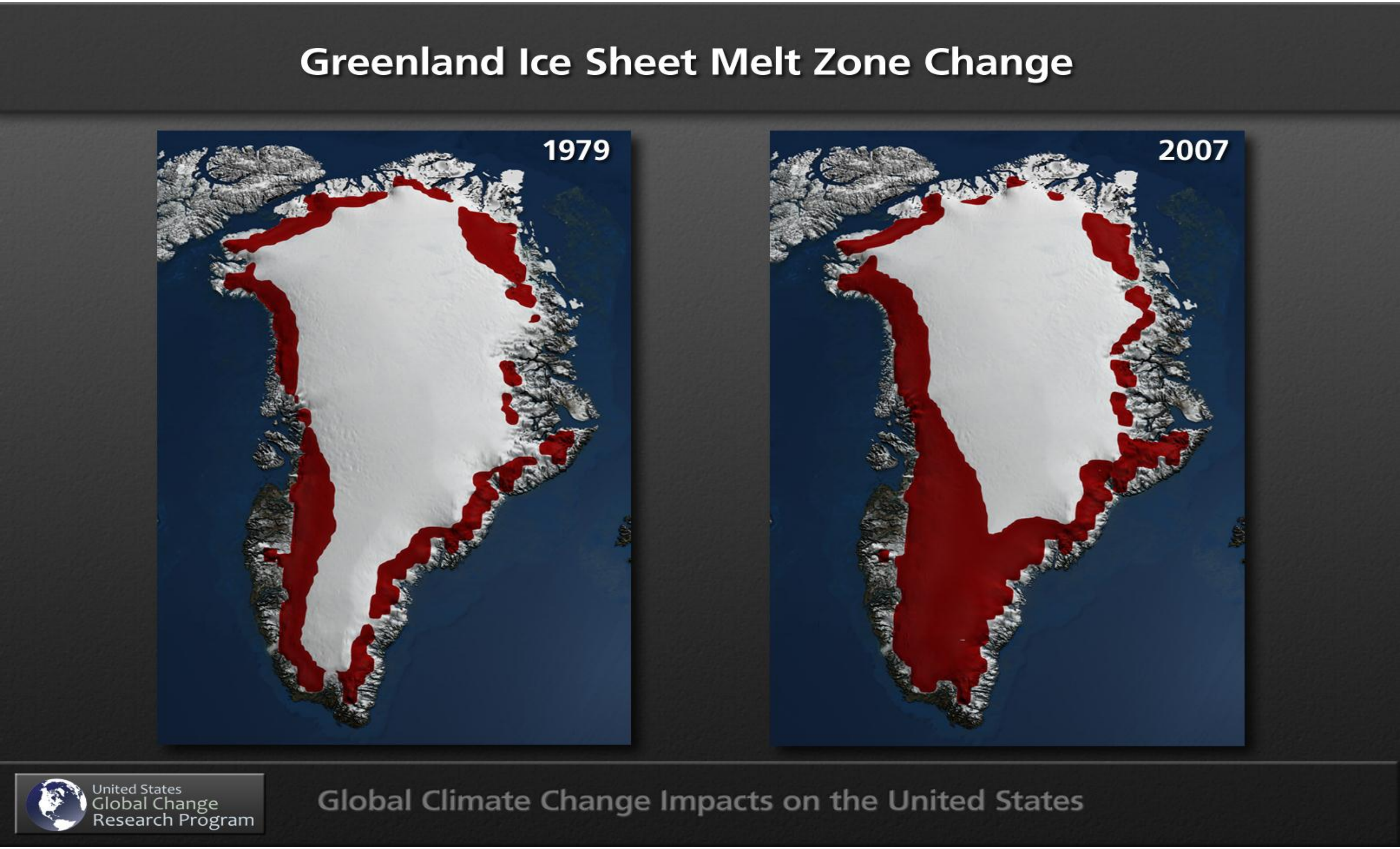
Arctic Monitoring and Assessment Program, 2011
Figure and Data from National Snow and Ice Data Center

Recent Findings:



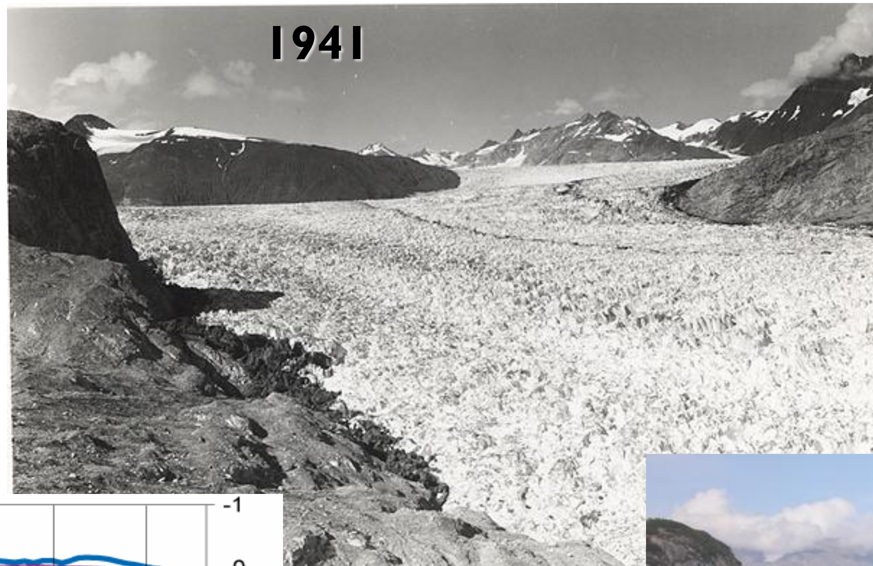
NSIDC data/UCAR image

Observed – Greenland Ice Sheet Melt



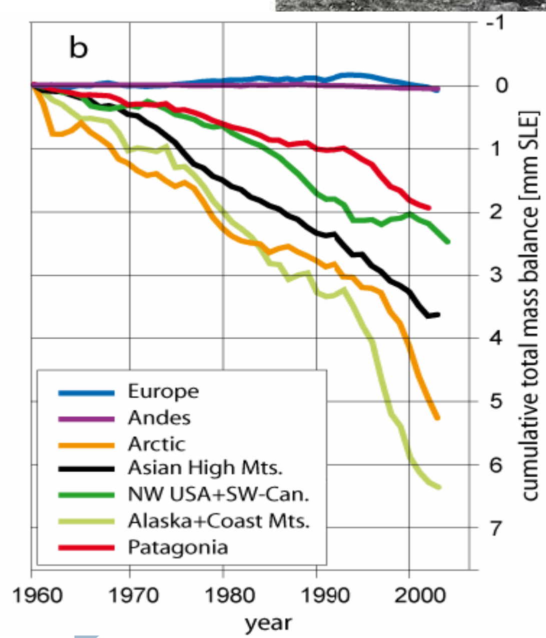
From Bob Corell

Observed – Rapidly Retreating Glaciers



Muir Inlet, Alaska
Glacier Bay National Park and Preserve

National Snow and Ice data center
http://nsidc.org/cgi-bin/gpd_run_pairs.pl



IPCC 2007

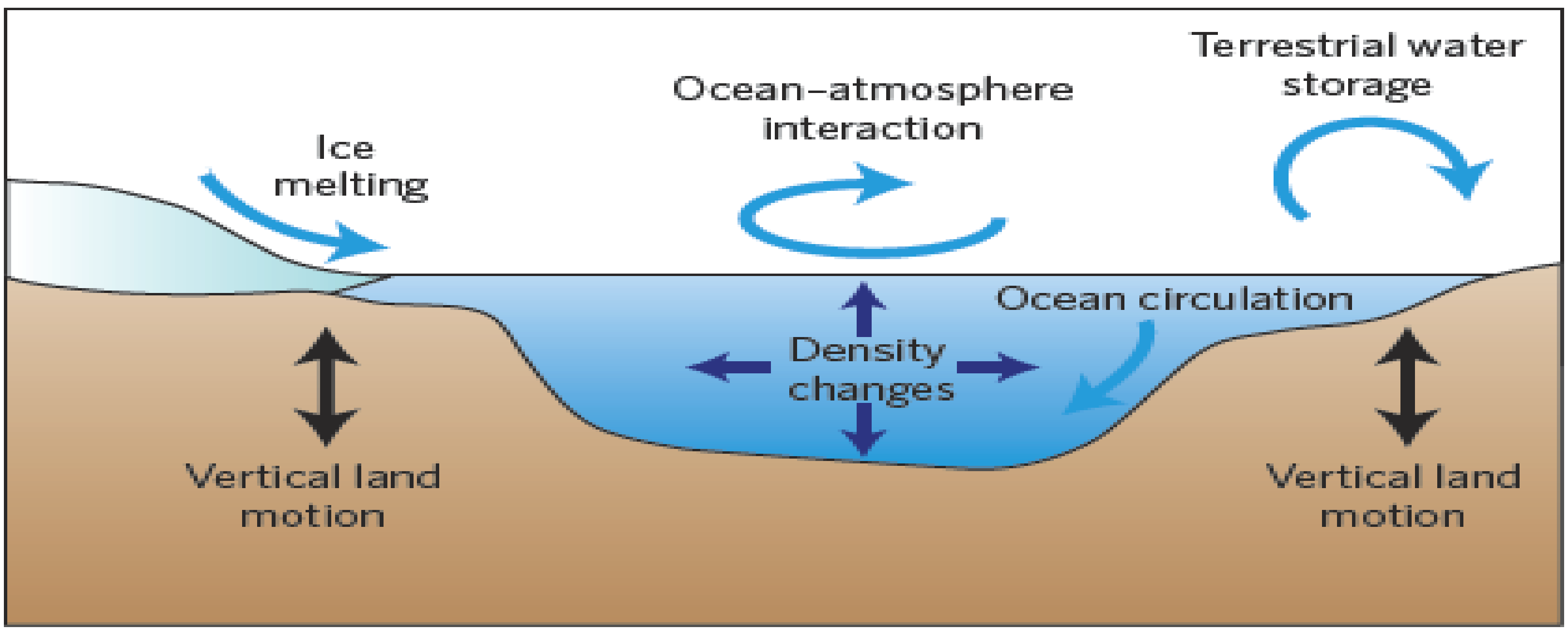
Changes Observed:

Thawing Methane Bogs- Siberia

From Bob Corell

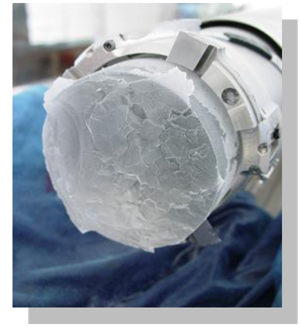
Changes Observed- Sea level

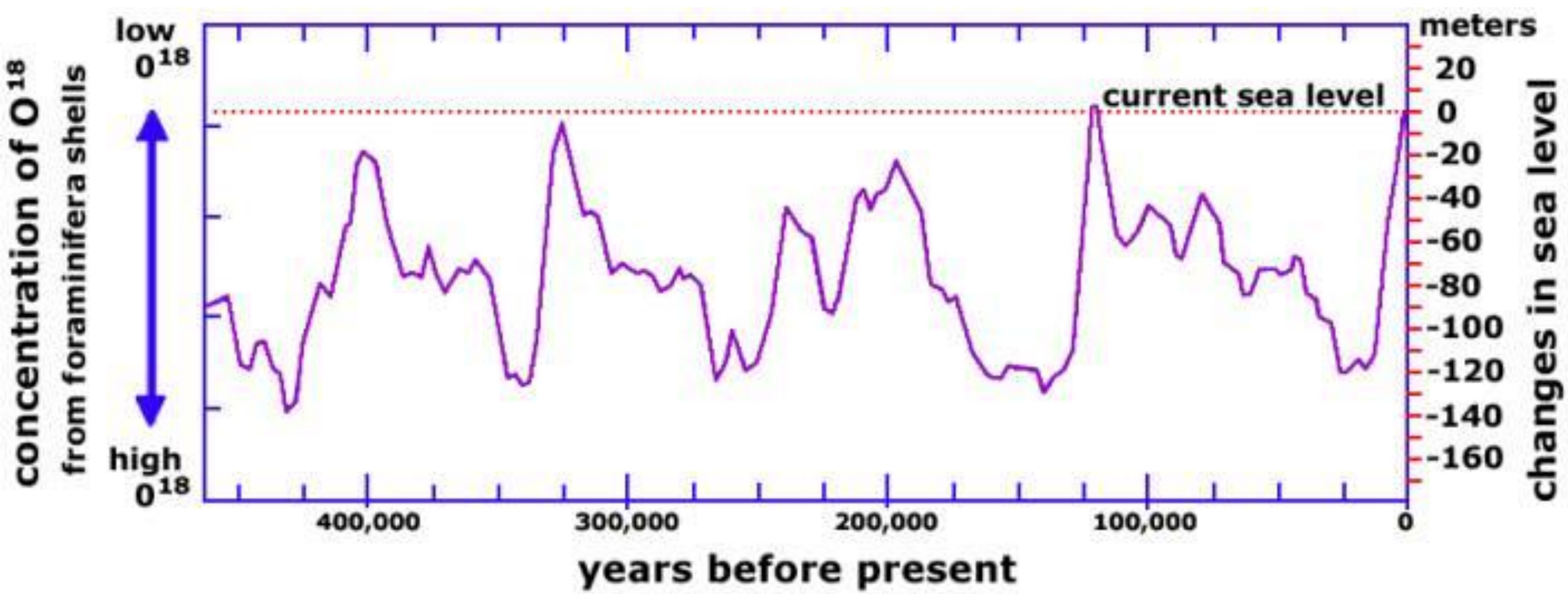
- Relative sea level depends on land rising/sinking; ocean circulation; wind patterns, etc.
- Sea level rise is due to warming oceans and melting glaciers, land-based ice caps and ice sheets
- Warmer oceans also contribute to stronger hurricanes and more rainfall



Past 400,000 Years:

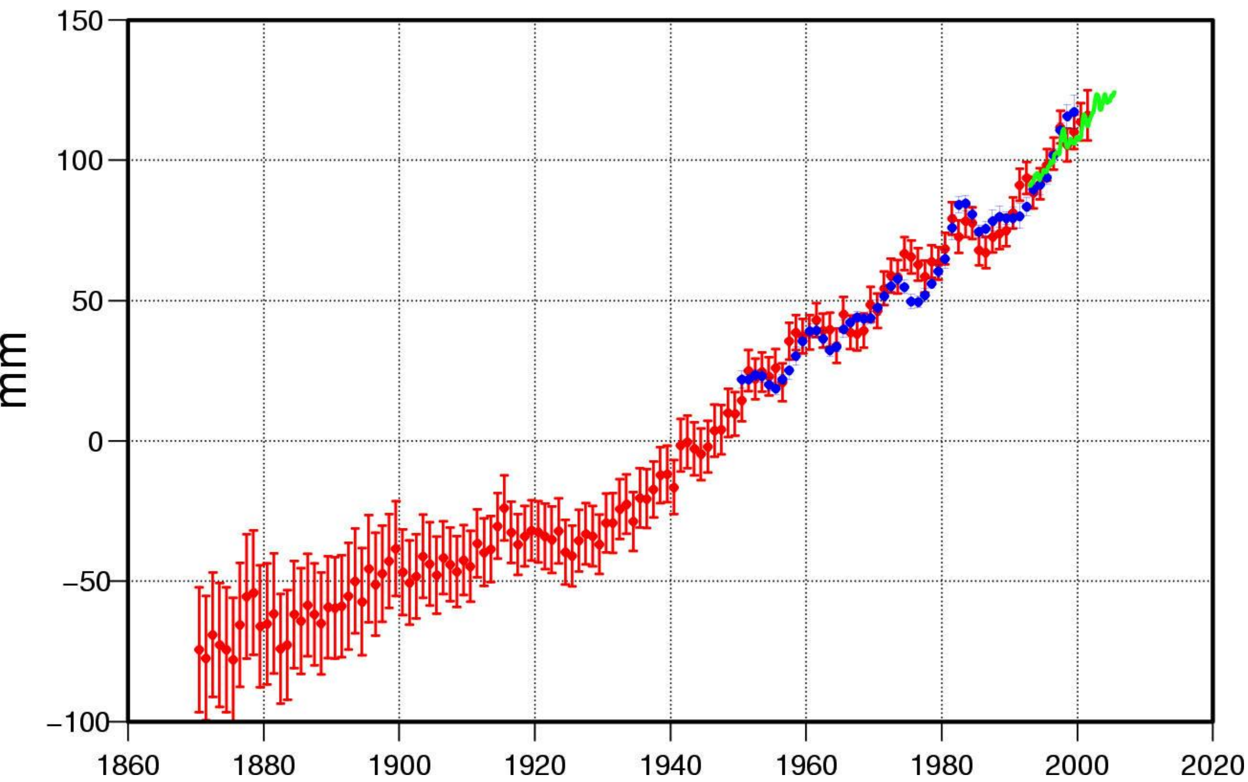
Sea level change





Source of data modified from CLIMAP isotopic data summarized in chart is from *Ice Ages* by John Imbrie and Katherine Imbrie, 1979

Global Mean SL Trends from Tide Gauges and Satellite Altimetry reveal an Acceleration!



Satellite Altimetry >3 mm/yr Leuliette et al. (2004)

Holgate and Woodworth (2004) 1.8 mm/yr1

Church *and White (2006)* ~1 mm/yr, 1870-1930

IPCC 2007
4th Assessment Report

Changes Observed - Sea level

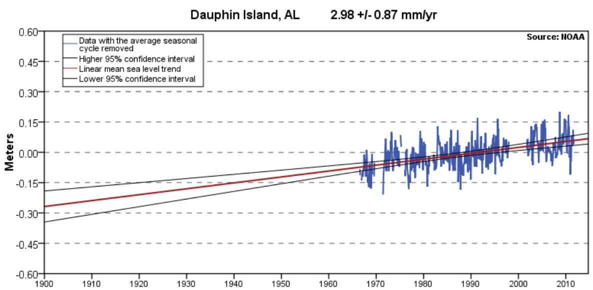
Some areas along the Atlantic and Gulf coasts - increases greater than 8 inches over the past 50 years.

Data Source: http://tidesandcurrents.noaa.gov/sltrends/sltrends.shtml

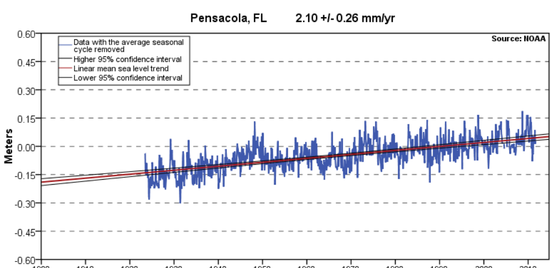
Observed US Climate Changes: Sea-level rise (and subsidence)

Sea level rise: ~8 in.

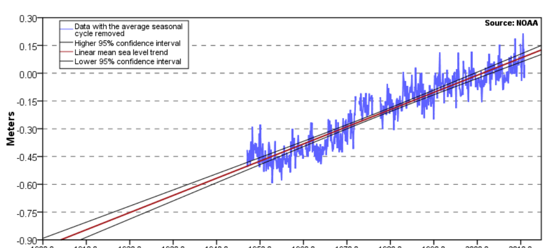
Dauphin Island, AL 0.98 feet/100 yrs



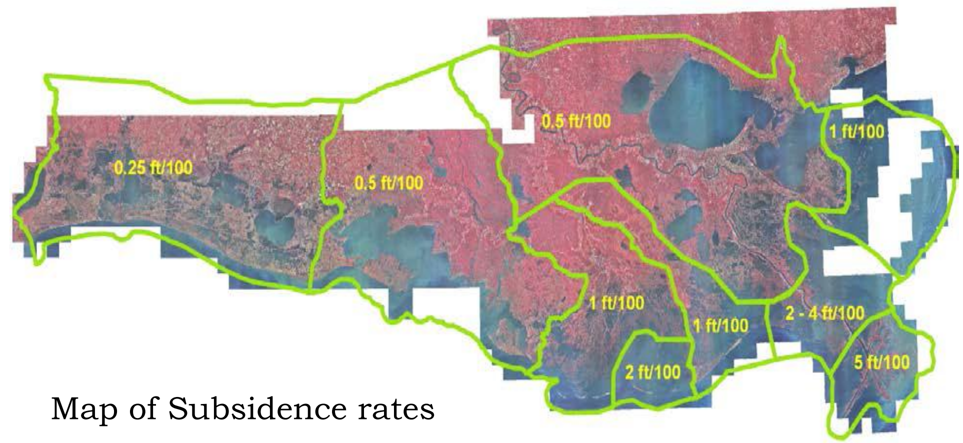
Pensacola, FL .69 feet/ century



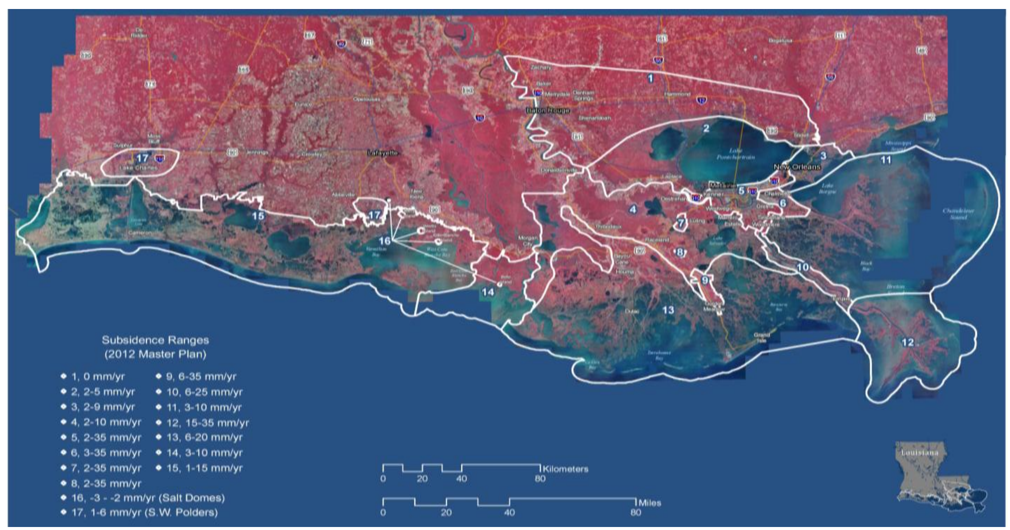
Grand Isle, LA 3.03 feet/ century



- From: NOAA SLR website

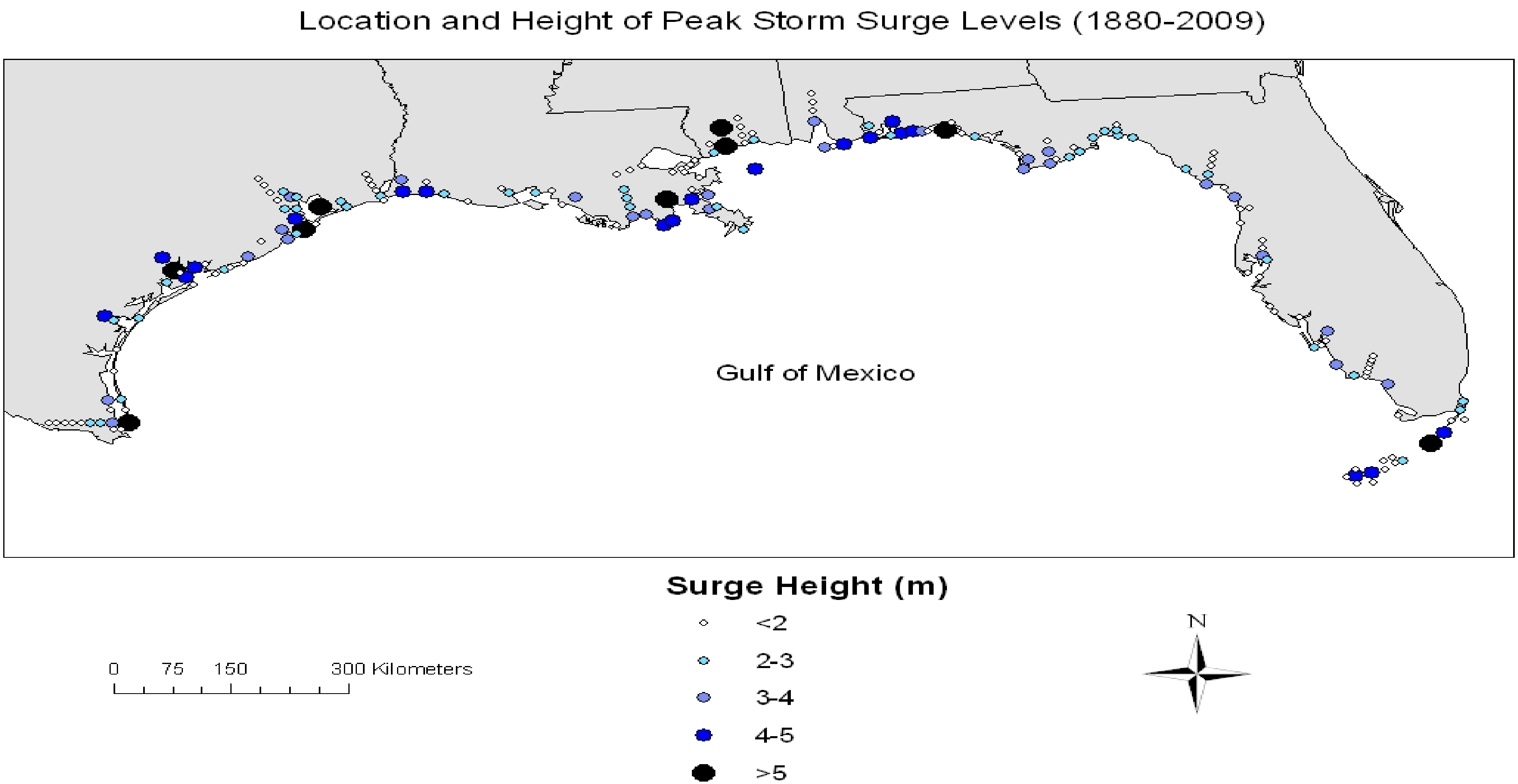


Map of Subsidence rates



Map of projected subsidence ranges for south Louisiana generated by the Subsidence Advisory Panel for the Louisiana CPRA Master Plan 2012 - from LA Technical Rpt - SLR

Gulf Coast Storm Surges



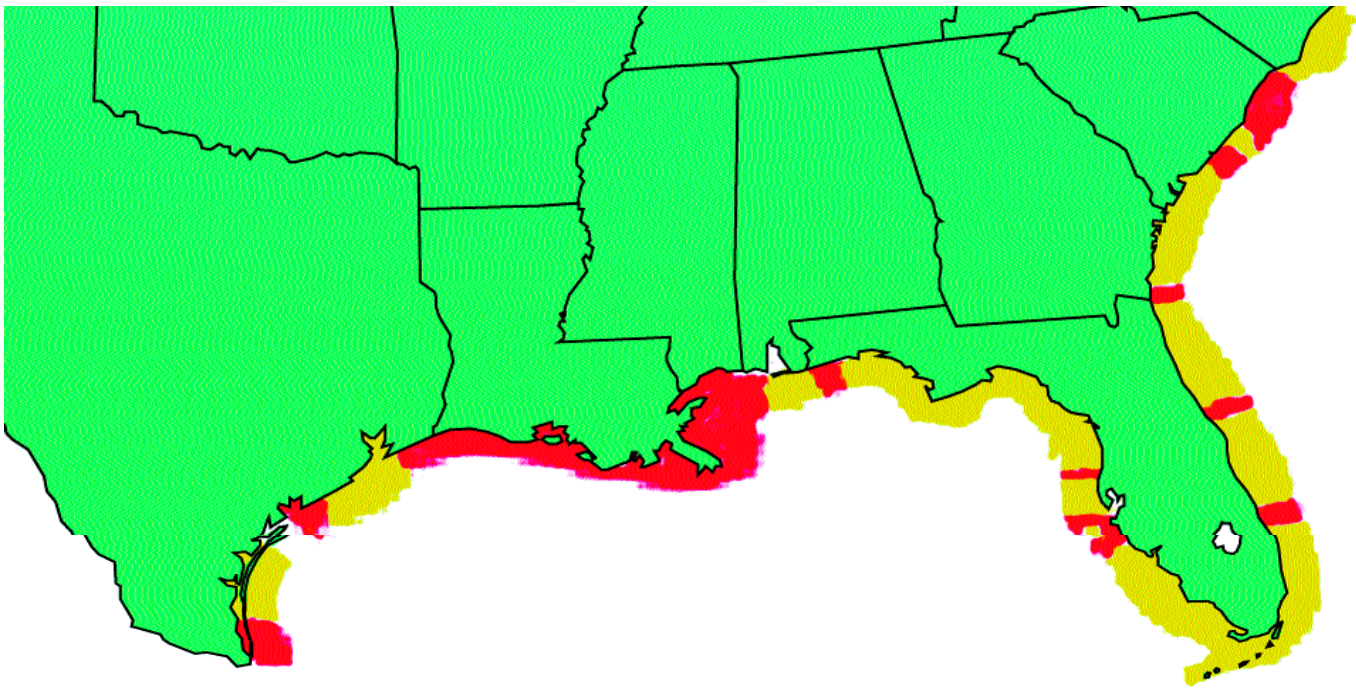
From: Hal Needham, 2010

Observed: Saltwater Intrusion

A “ghost swamp” in south Louisiana shows the effects of saltwater intrusion

Observed US Climate Changes

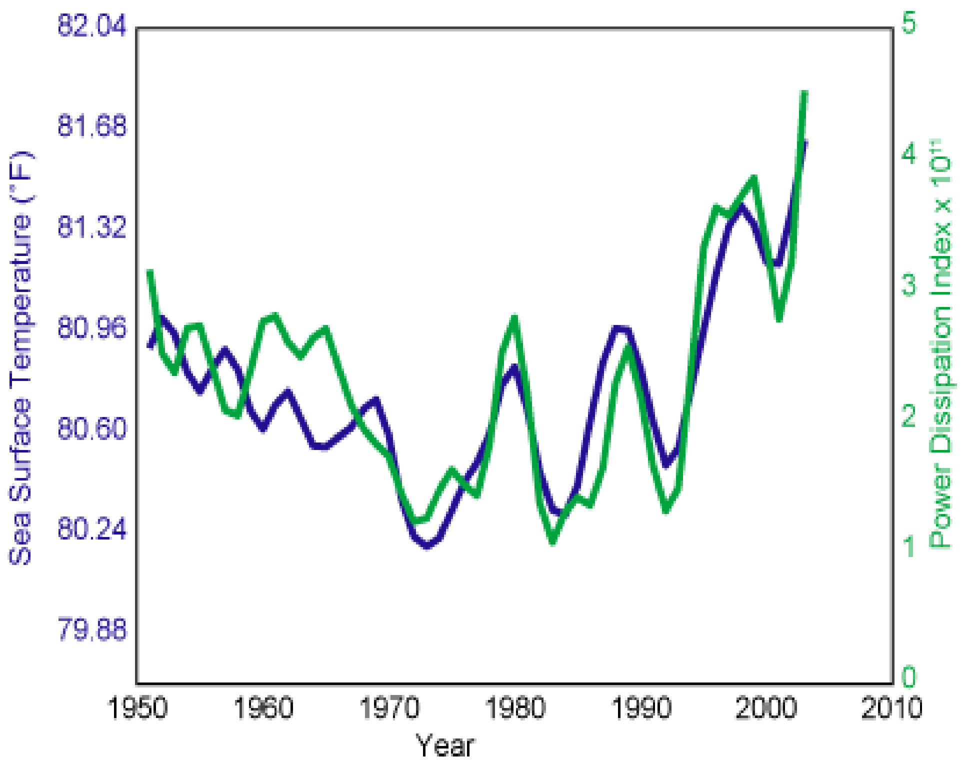
(eroding areas vulnerable)



Red= severely eroding Yellow= moderately eroding

From 1st US National Assessment

Observed Relationship between SST and Hurricane Power in the N. Atlantic Ocean



Observed sea surface temperature (sst) (blue) and the Power Dissipation Index (green) = combine frequency, intensity and duration for N. Atlantic hurricanes.

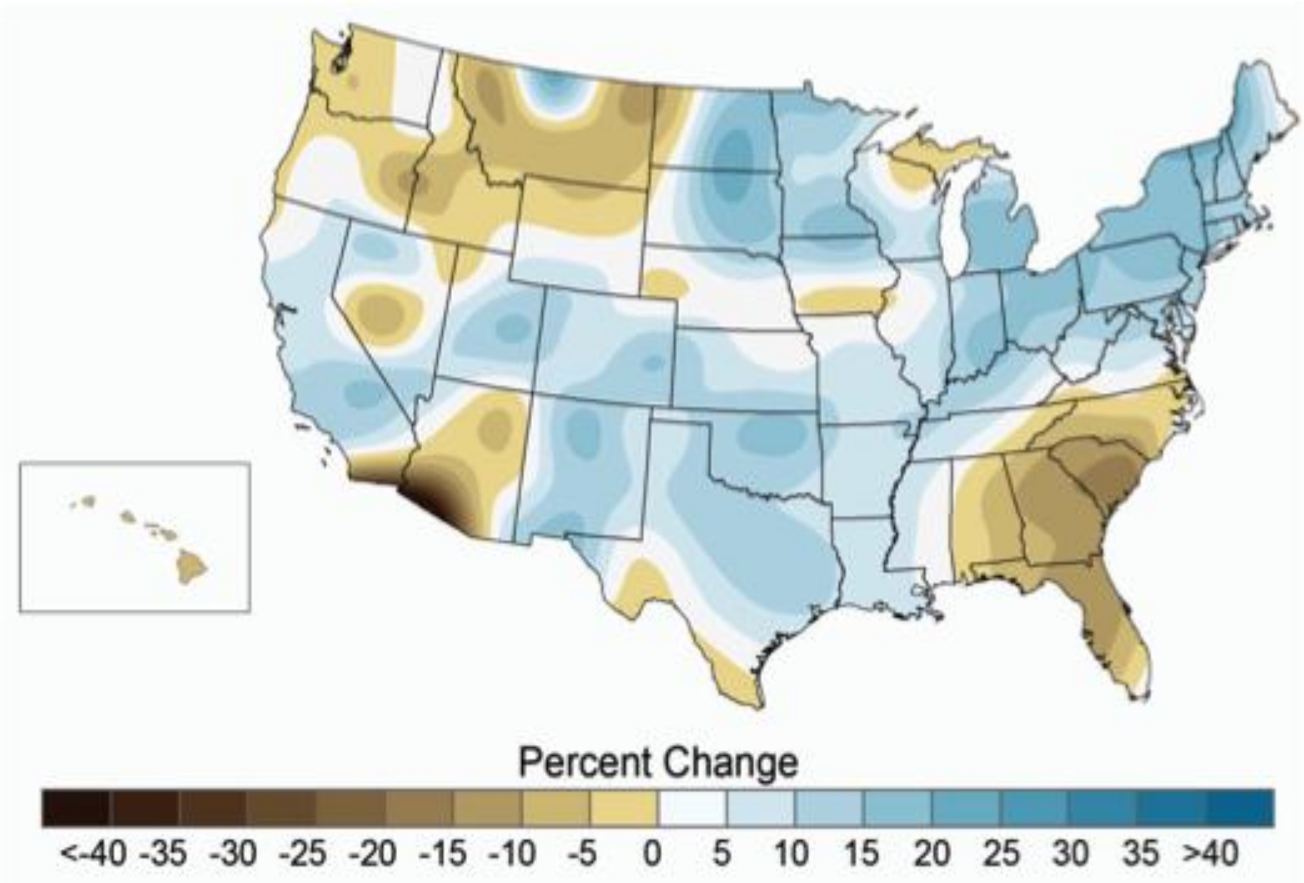
Hurricane rainfall and wind speeds likely to increase in response to warming.

Models suggest for each 1.8°F increase in tropical sea surface temperatures, rainfall rates will increase by 6 to 18%.

From: Global Climate Change Impacts
In the US, 2009 pg 35

Changes Observed: precipitation

annual average 1958-2008



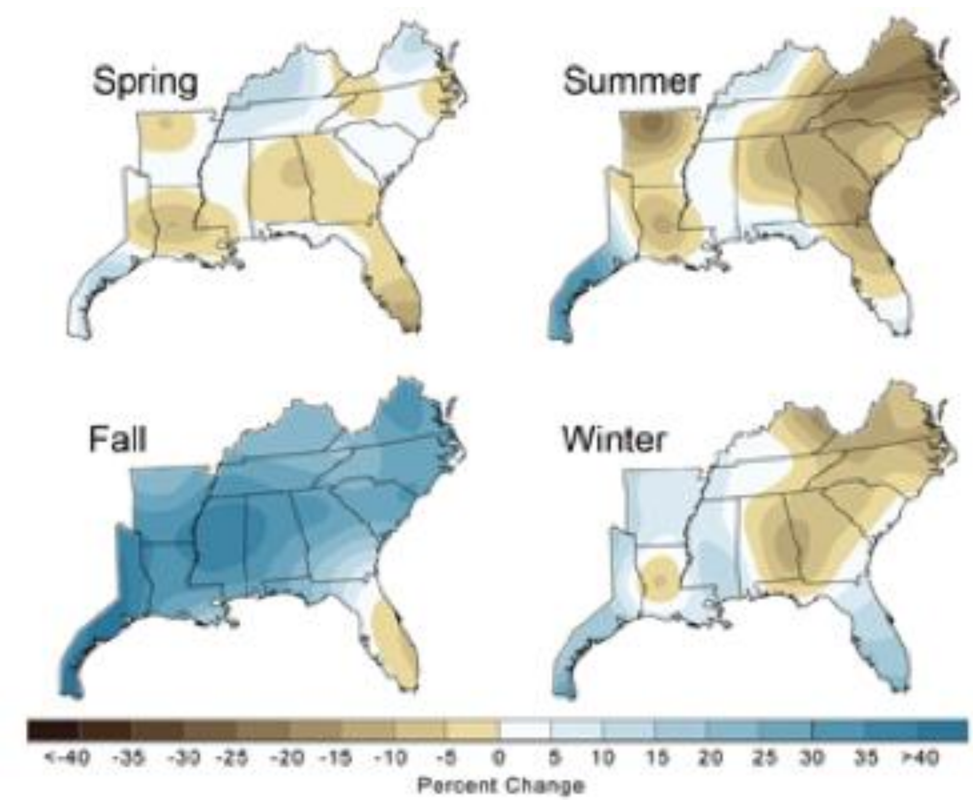
U.S. annual average precipitation has increased about 5 percent over the past 50 years

There have been important regional differences.

From: Global Climate Change Impacts In the US, 2009 pg 30

Local Changes in Precipitation

Observed Changes in Precipitation
1901 to 2007



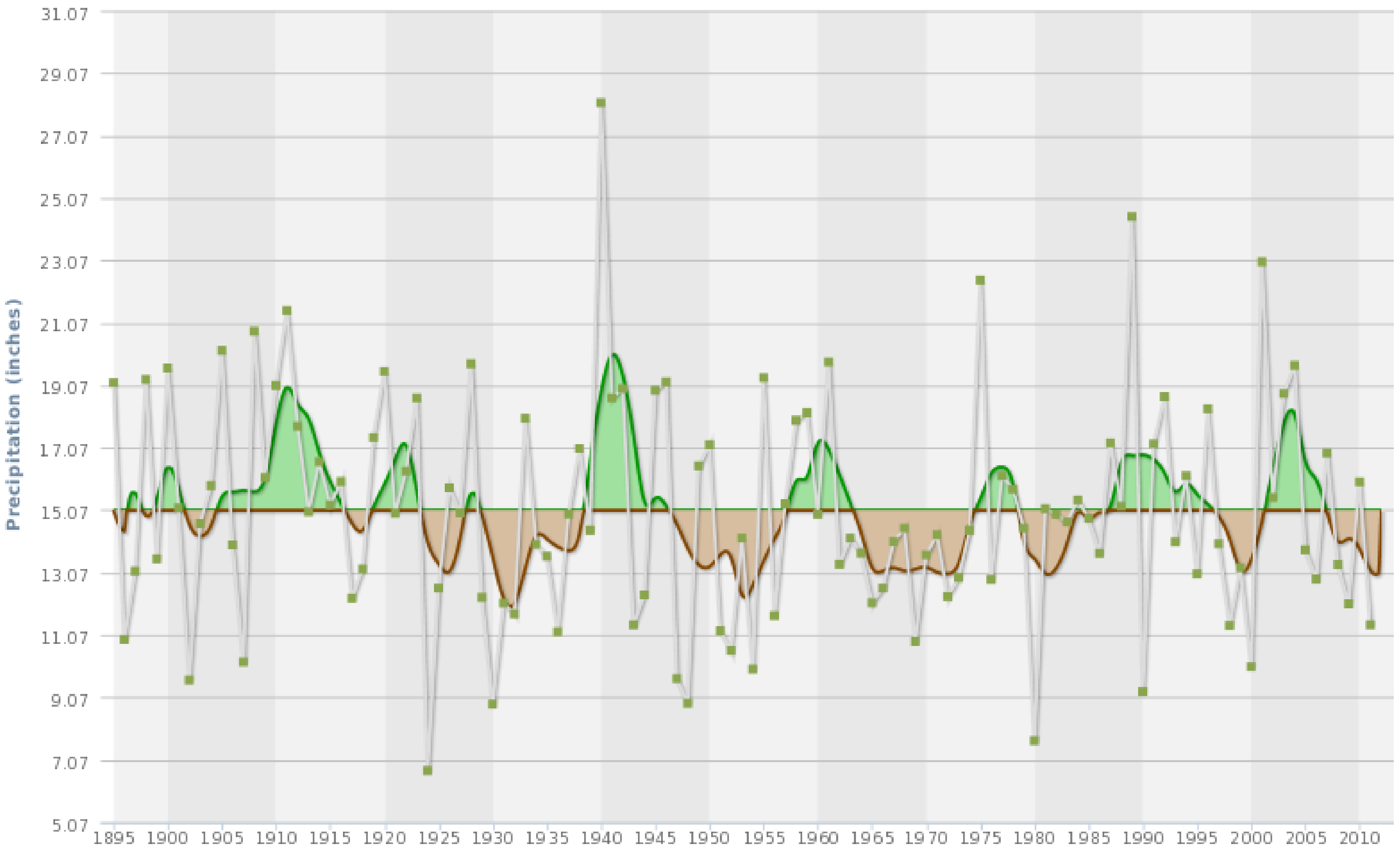
Average **fall** precipitation in the Southeast *increased* by 30% since the early 1900s, **summer** and **winter** precipitation *declined* by nearly 10 % in the eastern part of the region.

Southern Florida has experienced a nearly 10 % *drop* in precipitation in spring, summer, and fall.

The percentage of the Southeast region in drought has *increased* over recent decades.

From: Global Climate Change Impacts in the US, 2009, pg 111

Louisiana Precipitation: 1895-2010



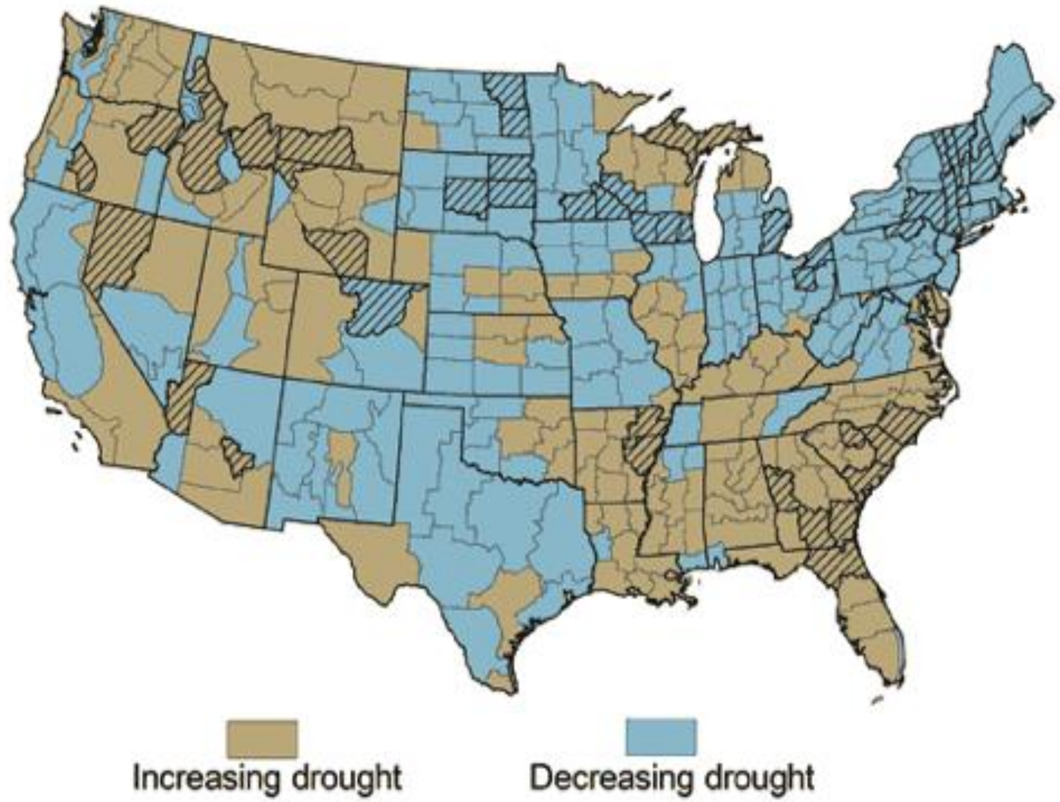
From: southernclimate.org

SUMMER

Changes Observed: precipitation

Drought trends: 1958-2007

End-of-summer drought trends as measured by the Palmer Drought Severity Index in each of 344 U.S. climate divisions.[144] Hatching indicates significant trends.



From: Global Climate Change Impacts In the US, 2009 pg 43

Changes Observed: precipitation intensity and amounts

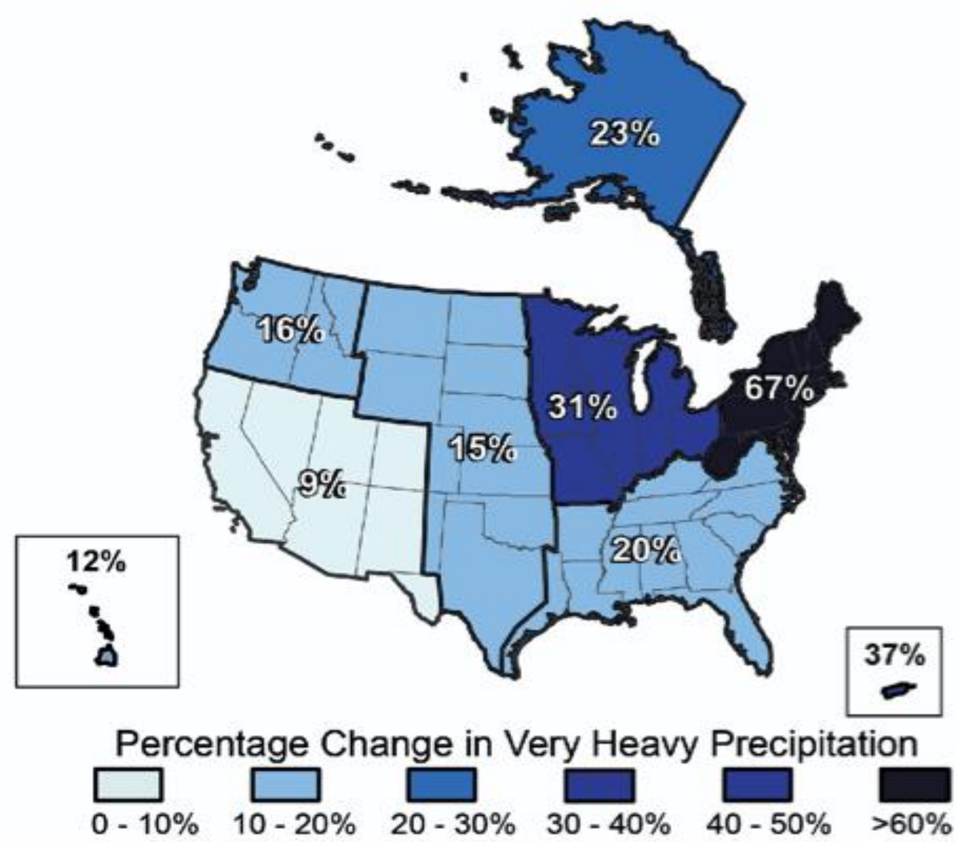
• Heavy downpours + 20% average in US over past 50 yrs

• Northeast and Midwest highest

• Precipitation + 5% average

• Shifting patterns show wet areas wetter, dry areas drier

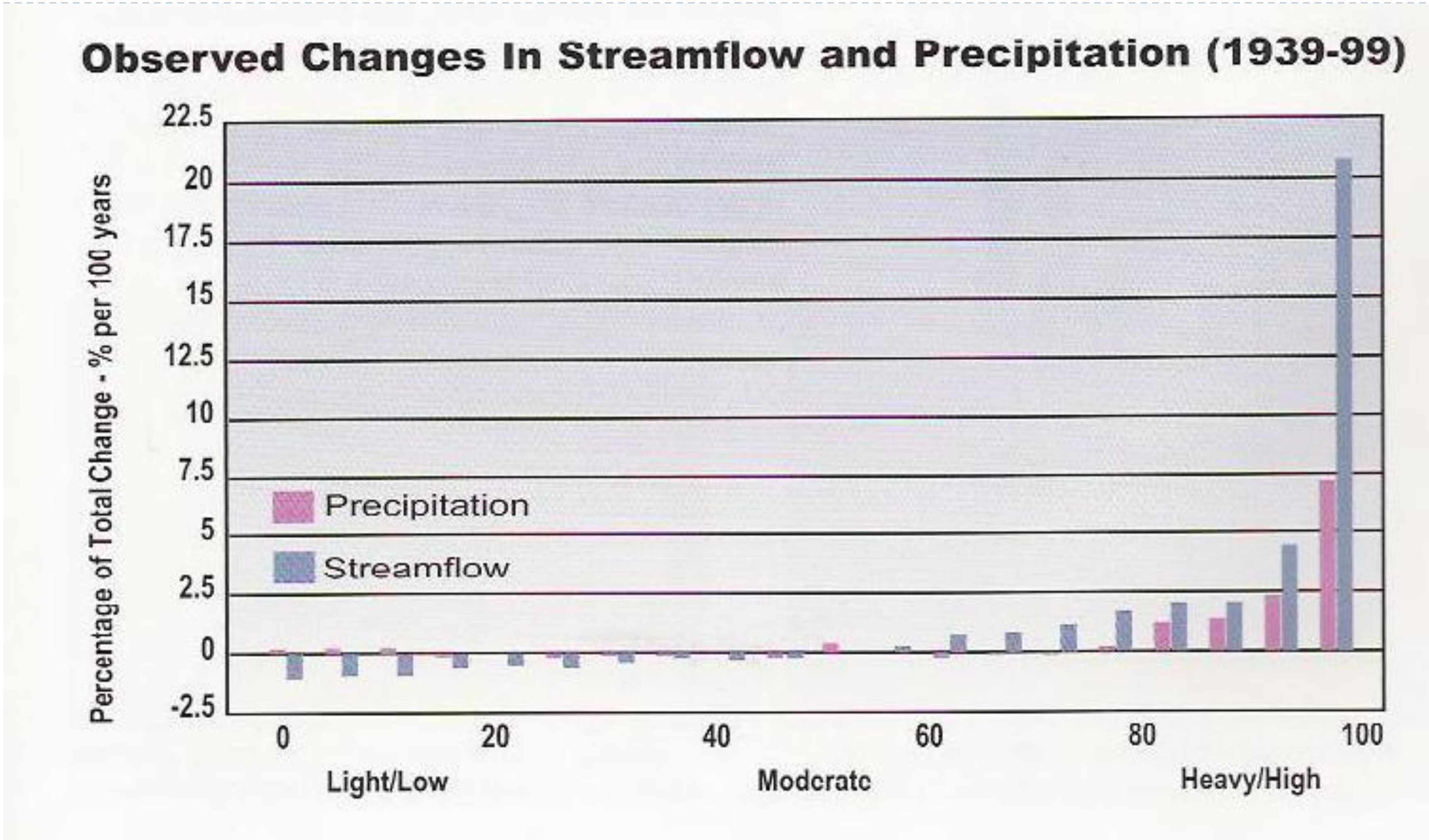
•Trend likely to continue



Increases in Very Heavy Precipitation: the heaviest 1% of all daily events from 1958-2007

From: Global Climate Change Impacts in the US, 2009 pg 32

Observed Changes: streamflow and precipitation



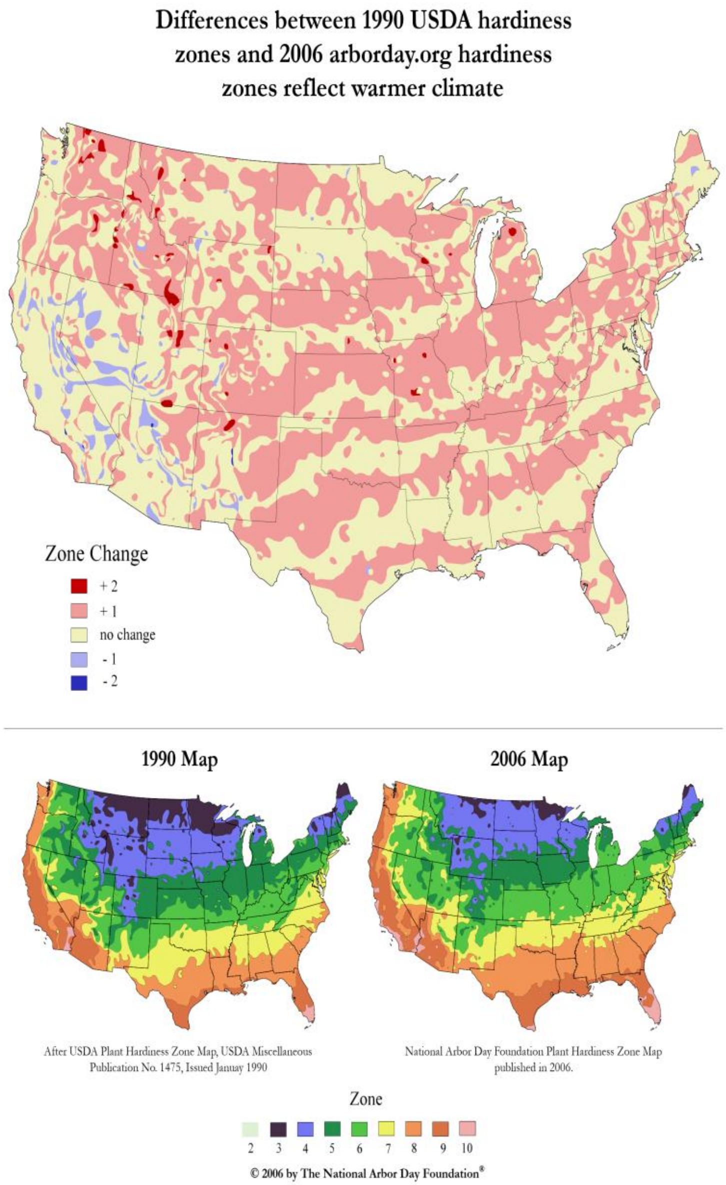
From 1st US National Assessment

Observed Changes: Hardiness zones: 1990-2006

Hardiness zones are areas determined by climate and temperature range for the purpose of describing which plants will succeed or fail within any specific region.

USDA divides the United States into 11 zones, 1 being the coldest and 11 the warmest. Plants living in Zones 1 - 4 are considered to be very hardy; in Zone 10, plants are described as tender (most will not survive freezing); zone 11 they are subtropical.

The USDA Zones are classified by average low temperature.



From: Arbor day website

Ecosystem Changes

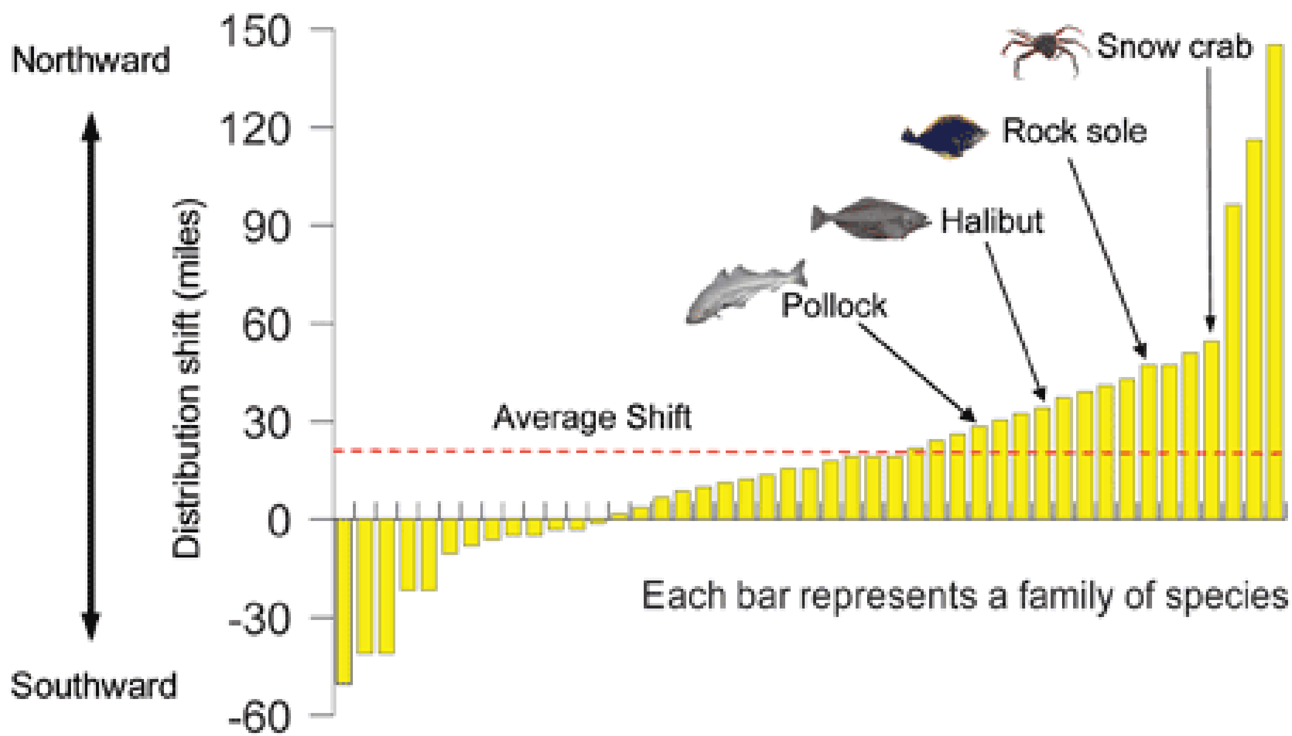
National Parks in Peril, 2009

"Mountain pine beetles in Colorado have crossed an elevational threshold that has not been seen before. Until the recent warmer weather, mountain pine beetles have not been able to withstand the cold temperatures above 9,500 ft."

Colorado State Forest Service

USGCRP, 2009

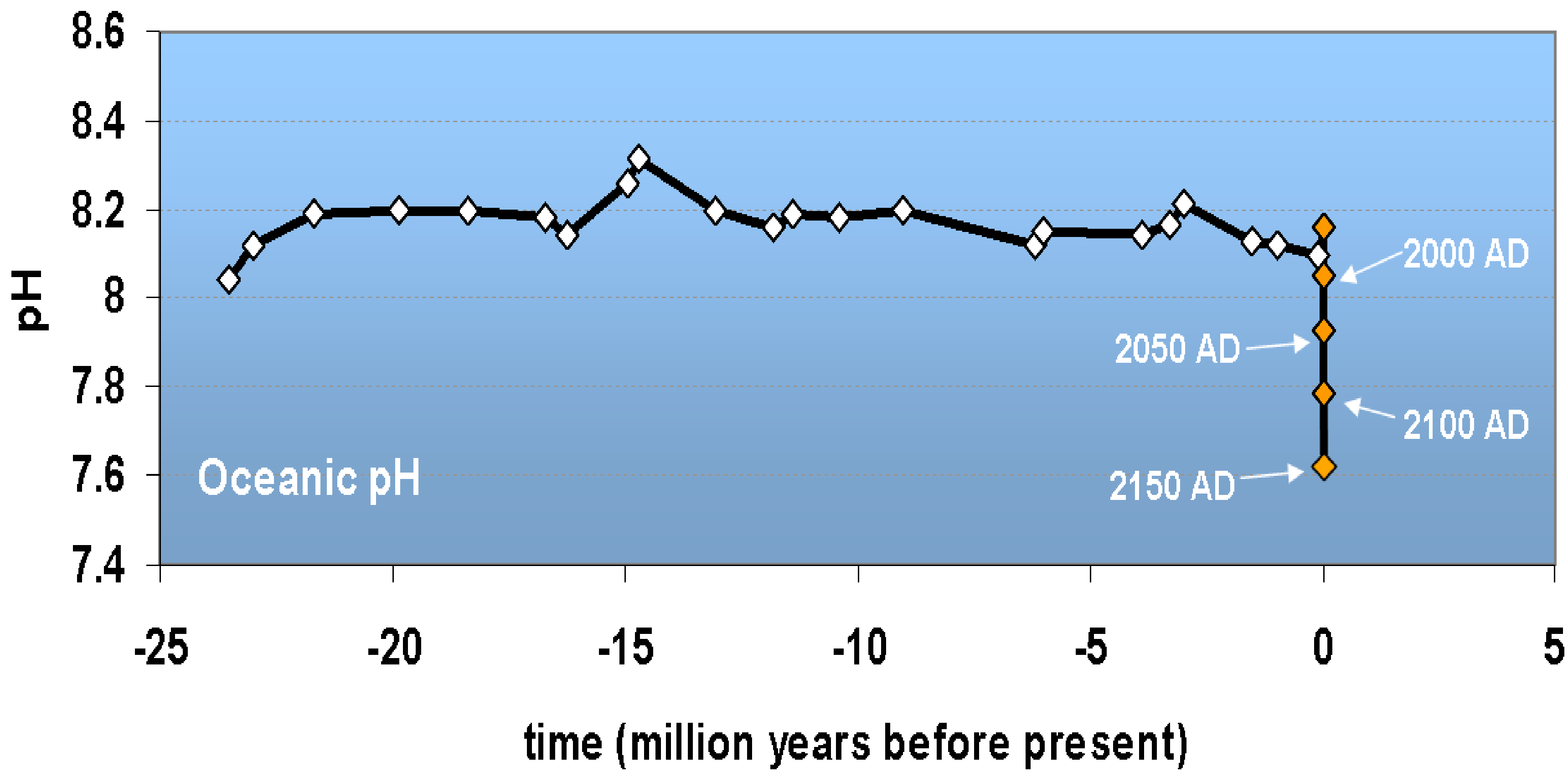
Changes Observed: Marine Species Shifting Northward 1982 to 2006



From: Global Climate Change Impacts in the US, 2009, pg 144

As air and water temperatures rise, marine species are moving northward, affecting fisheries, ecosystems, and coastal communities that depend on the food source. On average, by 2006, the center of the range for the examined species moved 19 miles north of their 1982 locations.

Ocean Acidification: Observed and Projected



From Bob Corell

Avoiding Dangerous Climate Change (Turley et al 2006)

Ocean Impacts from Increasing CO_2: Acidification

How do phytoplankton react to increased in CO_2 ?

Current Levels of CO_2

Scanning electron microscopy of calcifying phytoplankton

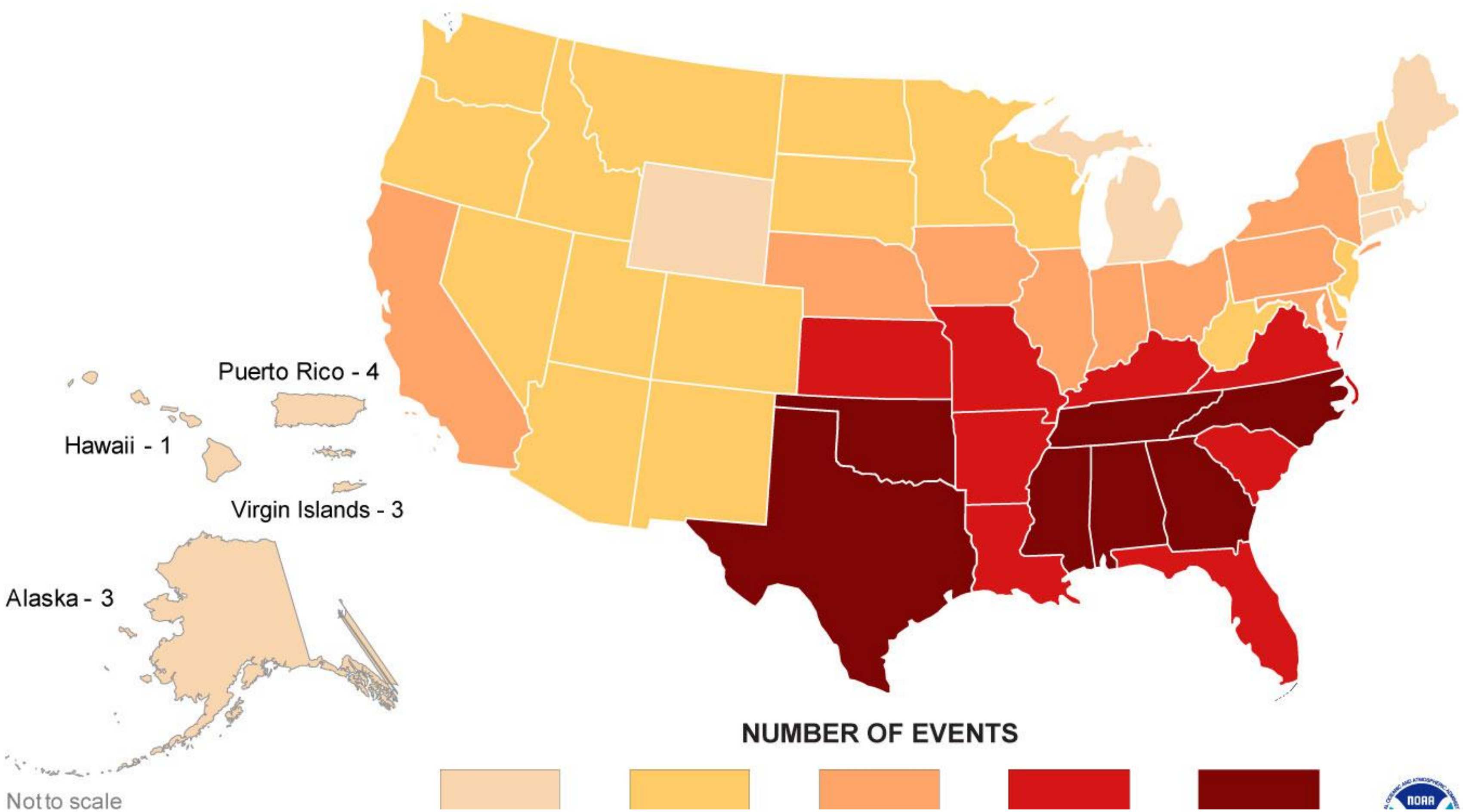
Calcidiscus Leptoporus

Projected Levels of CO_2

From: Bob Corell

Billion Dollar Weather/Climate Disasters

1980 - 2011



1-8 9-16 17-24 25-32 33-42

NOAA, NCDC from web

Key Messages

1. Climate change is here.

   We are already observing change.

2. The future will be different than the past and there will be consequences for the region. Specific local impacts will vary.

3. Gathering and sharing information today can help us to be better prepared for tomorrow.

Climate Change Impacts Are Not Distributed Evenly

For example…

Western drought, CA Dept. of Water Resources

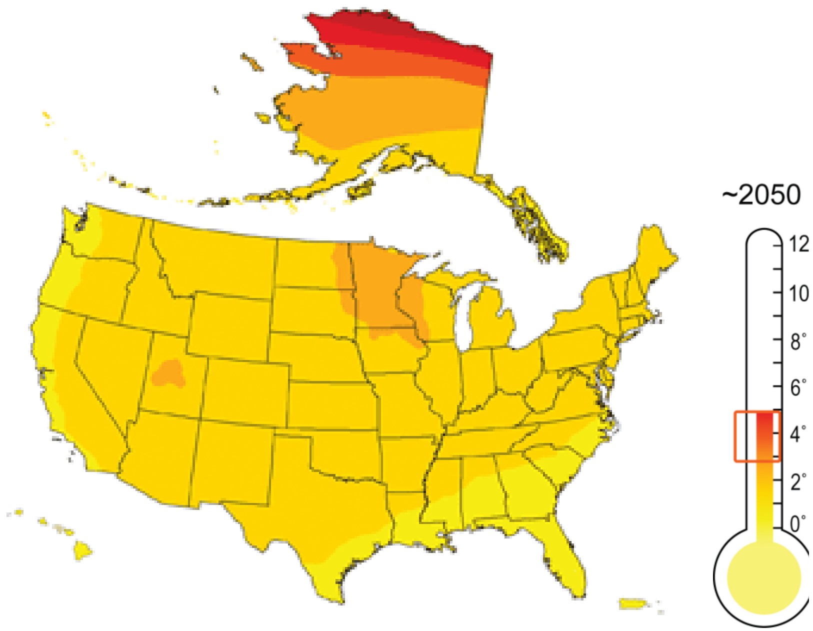
Midwestern flooding, NRCS

- Drought frequency has increased in the Southeast and much of the West
- Heavy precipitation has increased most in the Midwest and Northeast

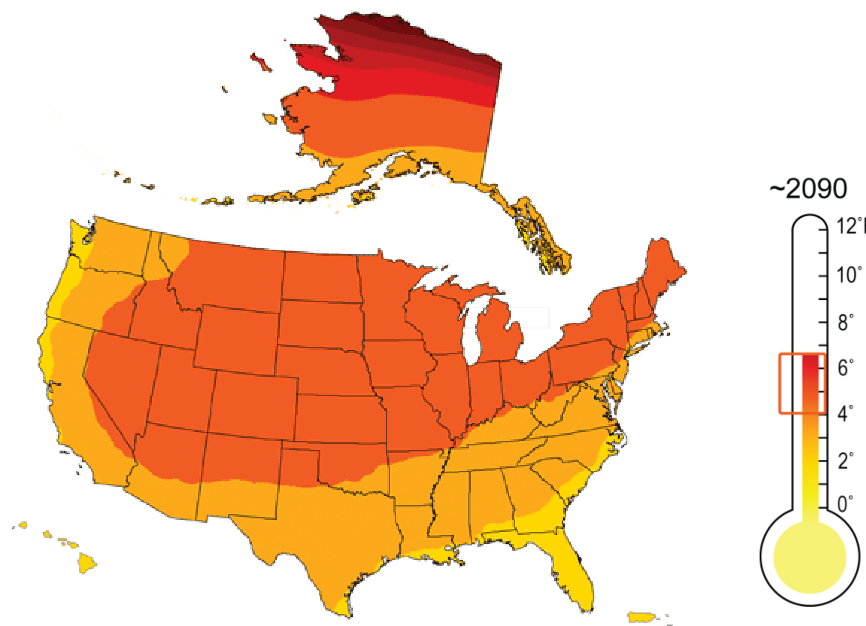
Projected U.S. Temperature Change (° F) under a Low Emissions Scenario

(compared to 1961-1979 Baseline)

Mid-Century
(2041-2059 average)



End-of-Century
(2080-2099 average)

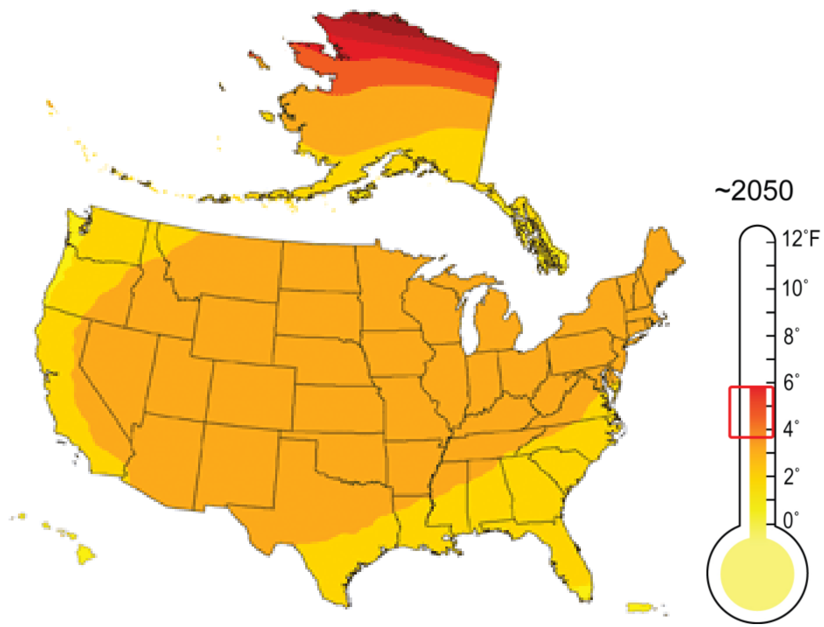


(USGCRP 2009)

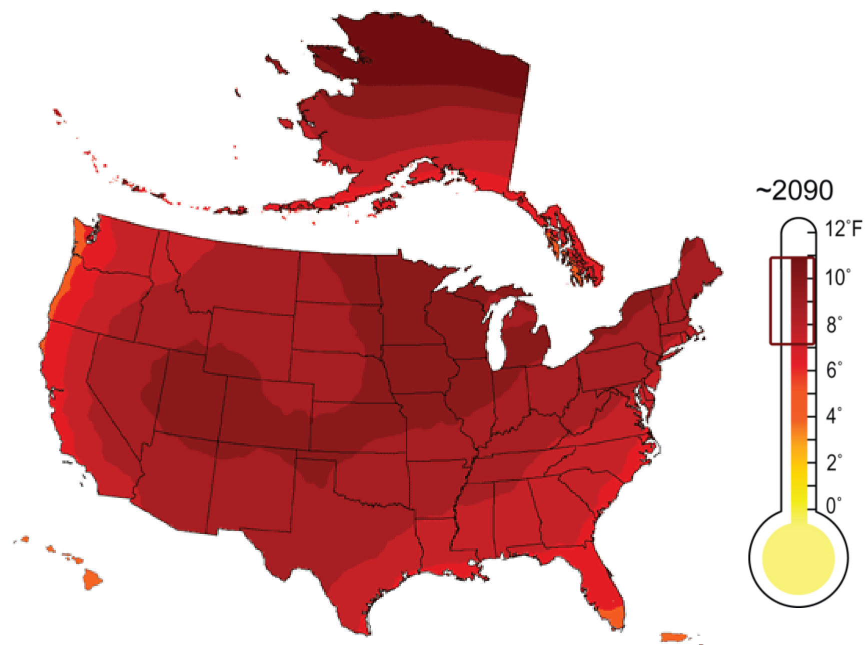
Projected U.S. Temperature Change (° F) under a High Emissions Scenario

(compared to 1961-1979 Baseline)

Mid-Century
(2041-2059 average)



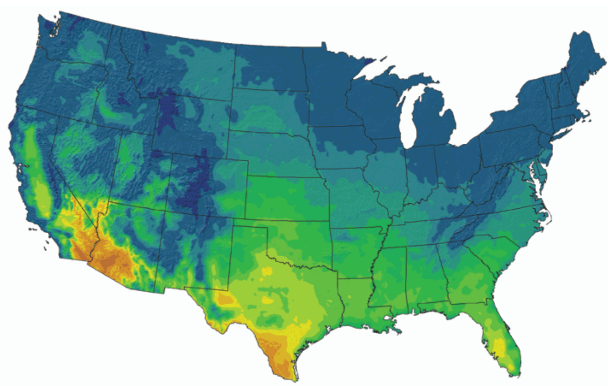
End-of-Century
(2080-2099 average)



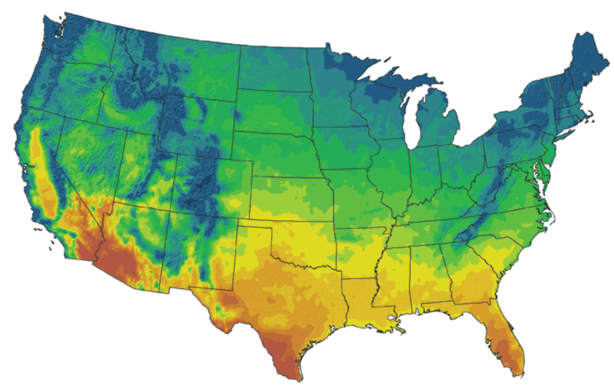
(USGCRP 2009)

Change in Number of Days Above 90° F

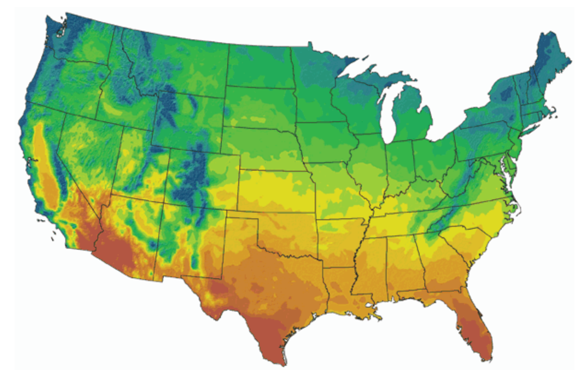
Recent Past
(1961-1979 Average)

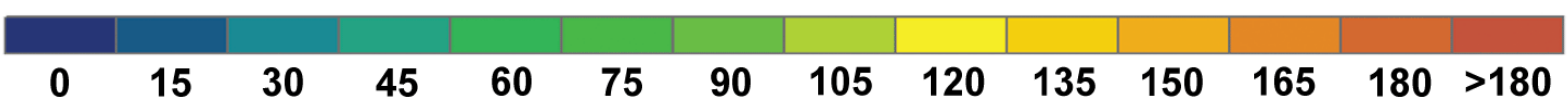


Projected End-of-Century
Lower Emissions Scenario
(2080-2099 average)



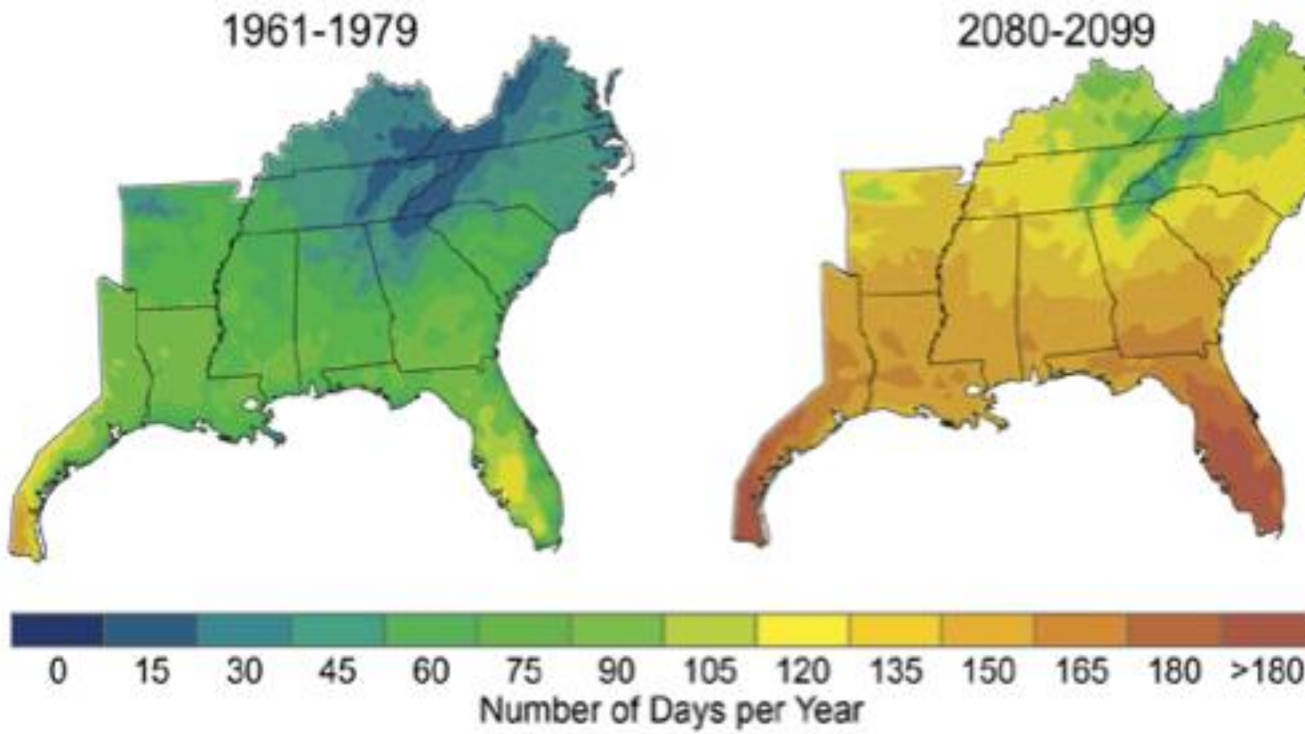
Projected End-of-Century
Higher Emissions Scenario
(2080-2099 average)





(USGCRP 2009)

Projected Number of Days per Year with Peak Temperatures over 90° F (high emissions)



The number of days per year with peak temperature over 90°F is expected to rise significantly, especially under a higher emissions scenario[91]. By the end of the century, projections indicate that North Florida will have more than 165 days (nearly six months) per year over 90°F, up from roughly 60 days in the 1960s and 1970s. The increase in very hot days will have consequences for human health, drought, and wildfires.

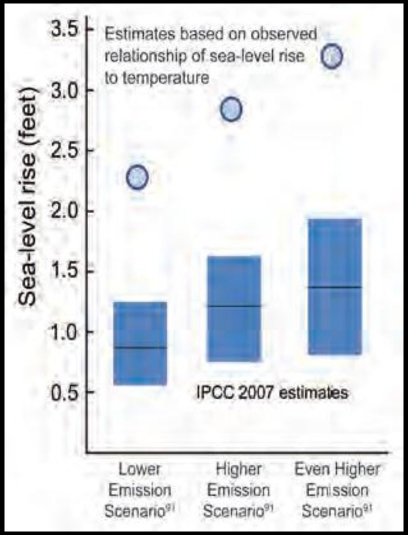
From: Global Climate Change Impacts in the US, 2009, pg 112

Loss of Coastal Plant Communities

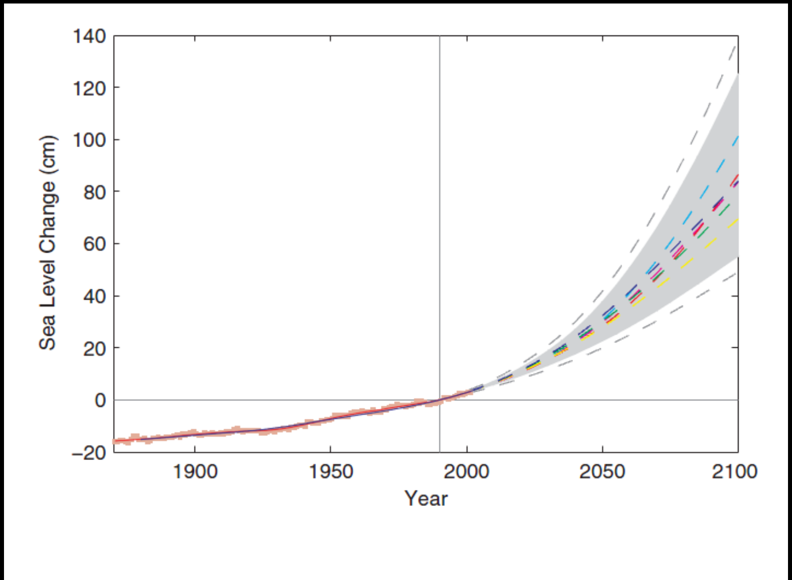
"It has been estimated that 3 feet of sea-level rise (within the range of projections for this century) would inundate about 65 % of the coastal marshlands and swamps in the contiguous United States."

U.S. Global Change Research Program (2009)31

Everglades National Park


Sea-level rise (feet)
3.5
3.0
2.5
2.0
1.5
1.0
0.5
Estimates based on observed relationship of sea-level rise to temperature
IPCC 2007 estimates
Lower Emission Scenario[91]
Higher Emission Scenario[91]
Even Higher Emission Scenario[91]

(USGCRP 2009)


Sea Level Change (cm)
140
120
100
80
60
40
20
0
−20
1900
1950
2000
2050
2100
Year

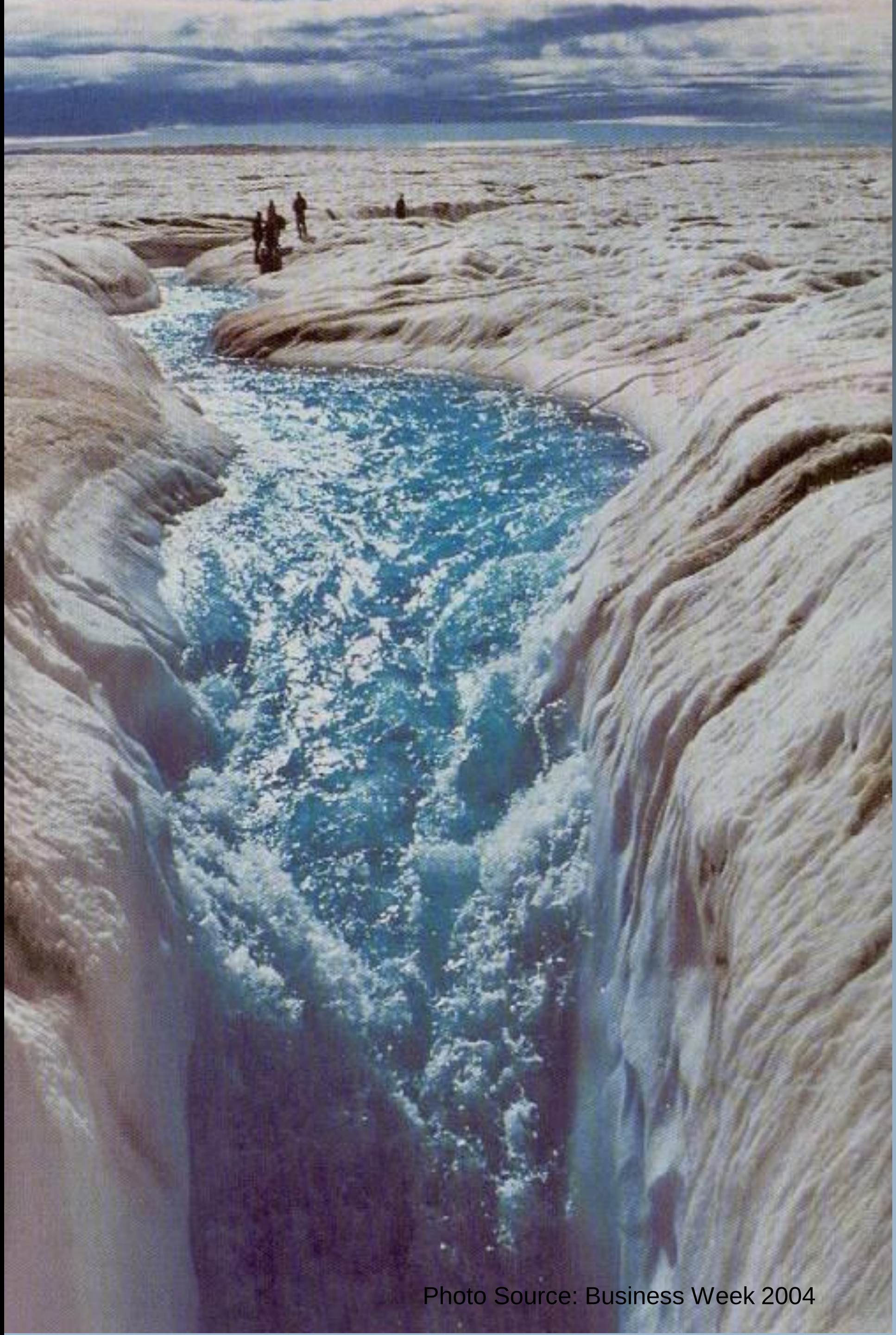
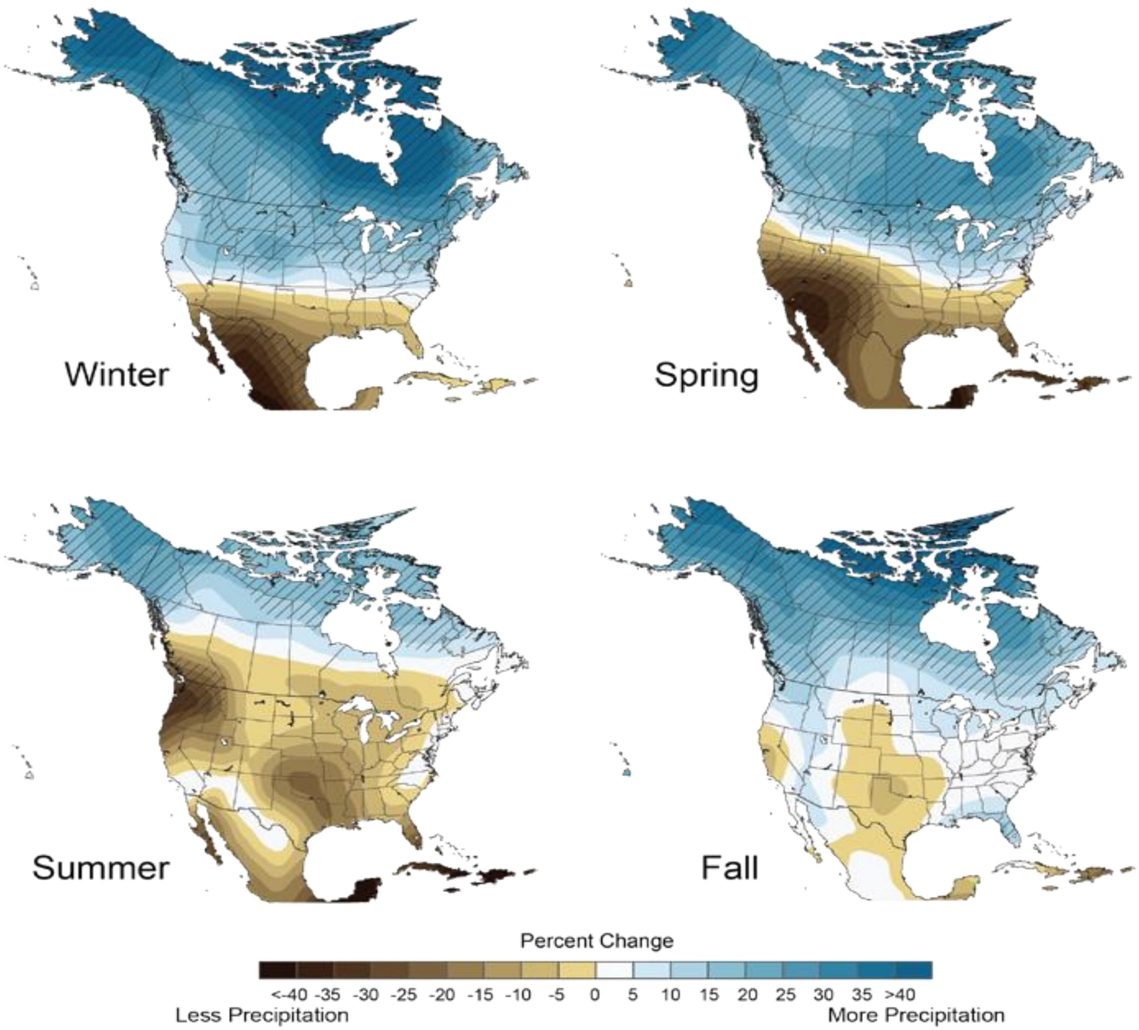


Photo Source: Business Week 2004

Projected Change: N. American Precipitation



Late Century (2080-2099): higher emissions scenario.

For spring, climate models agree that northern areas are likely to get wetter, and southern areas drier.

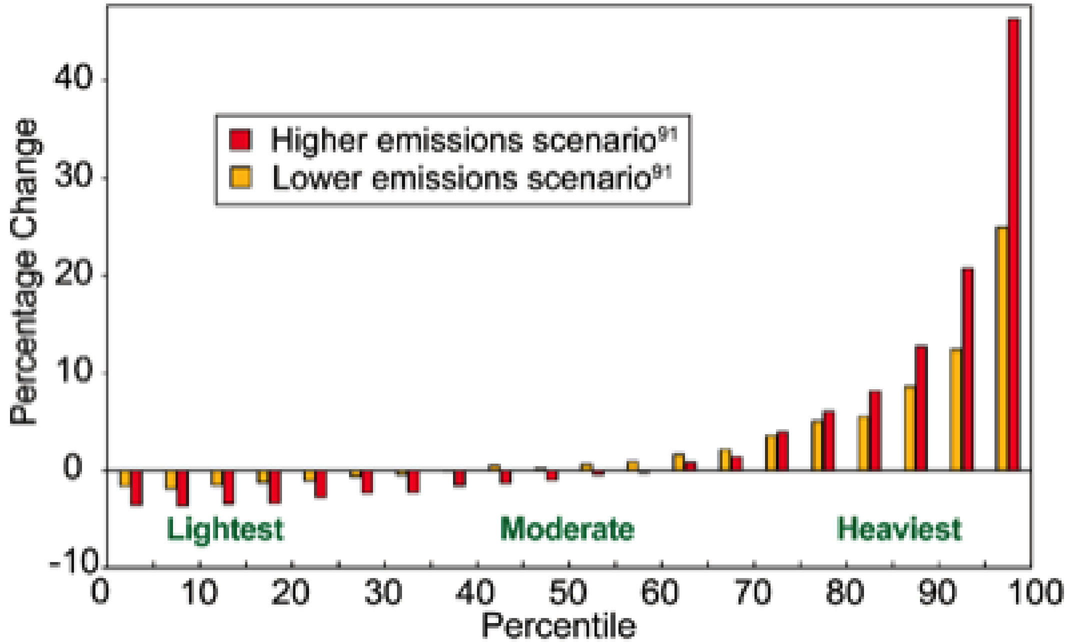
There is less confidence in exactly where the transition between wetter and drier areas will occur.

Highest confidence in the hatched areas.

From: Global Climate Change Impacts In the US, 2009 pg 31

Projected Change in Precipitation Intensity:

change from 1990s average to 2090s average



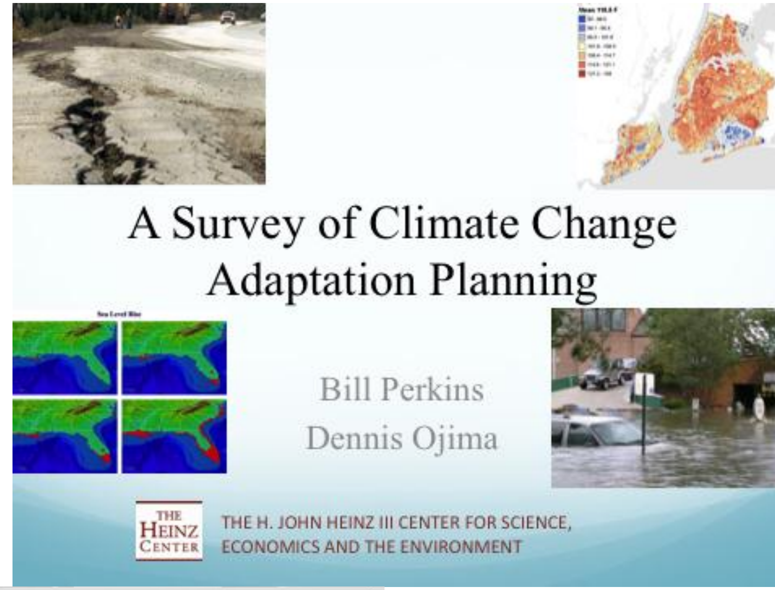
Amount of precipitation falling in light, moderate, and heavy events in North America. Projected changes are displayed in 5 percent increments from the lightest drizzles to the heaviest downpours. Lightest precipitation is projected to decrease, while the heaviest will increase, continuing the observed trend. The higher emission scenario yields larger changes. Projections are based on the models used in the IPCC 2007 Fourth Assessment Report.

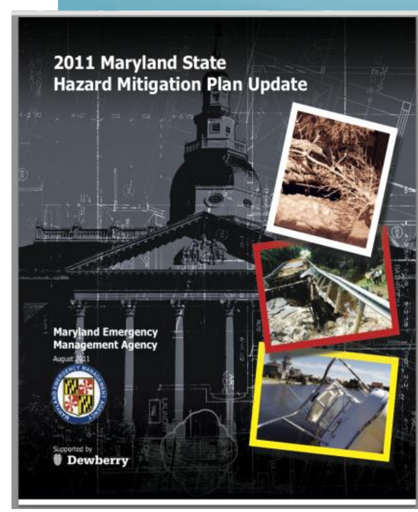
From: Global Climate Change Impacts in the US, 2009 pg 32

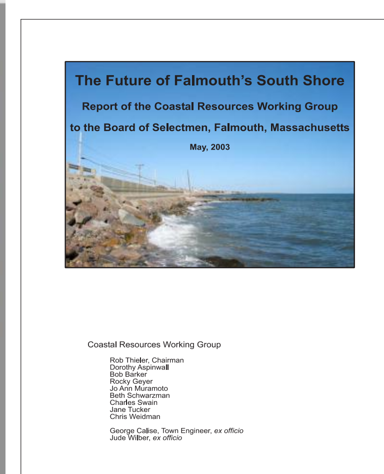
Thinking About Possible Consequences

Many options:

- Learn from others: guidebooks and specific projects, comprehensive outlooks
- How will present situations, problems, hazards change under a changing climate?
- Examine various sectors under projected changes
  - Identify vulnerabilities
  - Define tipping points for actions
- Watch for new trends: changes in timing, new locations for problems, new problems





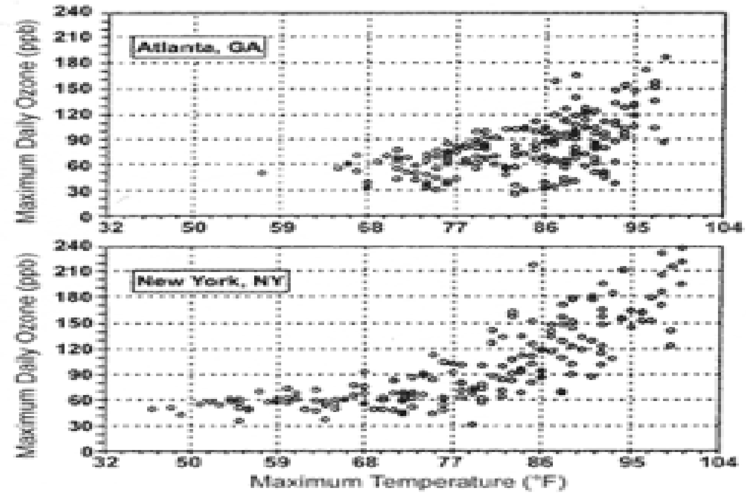


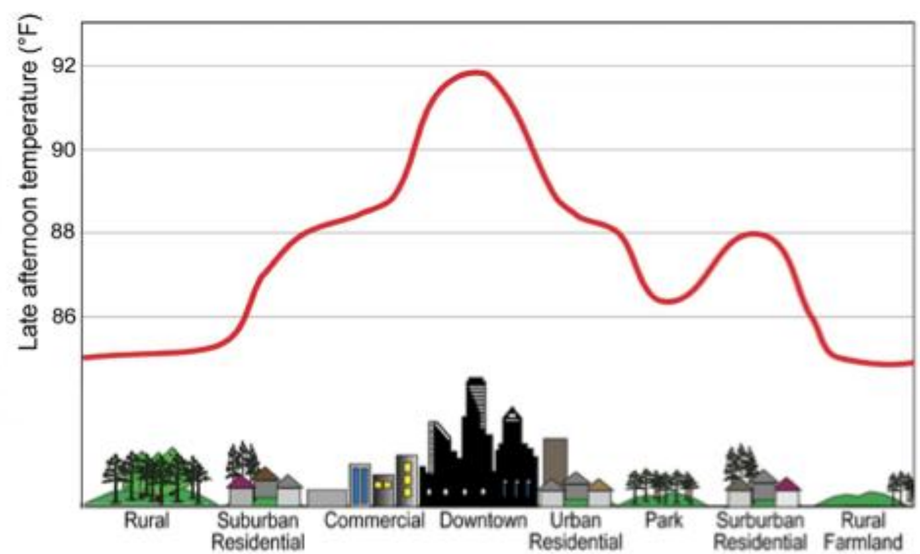
Present Problems Likely to Get Worse

- **Urban Air Quality:**
  Relationship between temperature and air quality: Higher temps - more challenging to meet air quality standards

- **Urban Heat Island Effect:**
  Increased temperatures day and night – more heat held by urban areas

- **Rate of Sea-level Rise:**
  Relationship to water temperature and melting glaciers, rate of local subsidence -> salt water intrusion, storm surge, flooding





From: Global Climate Impacts in the US, 2009

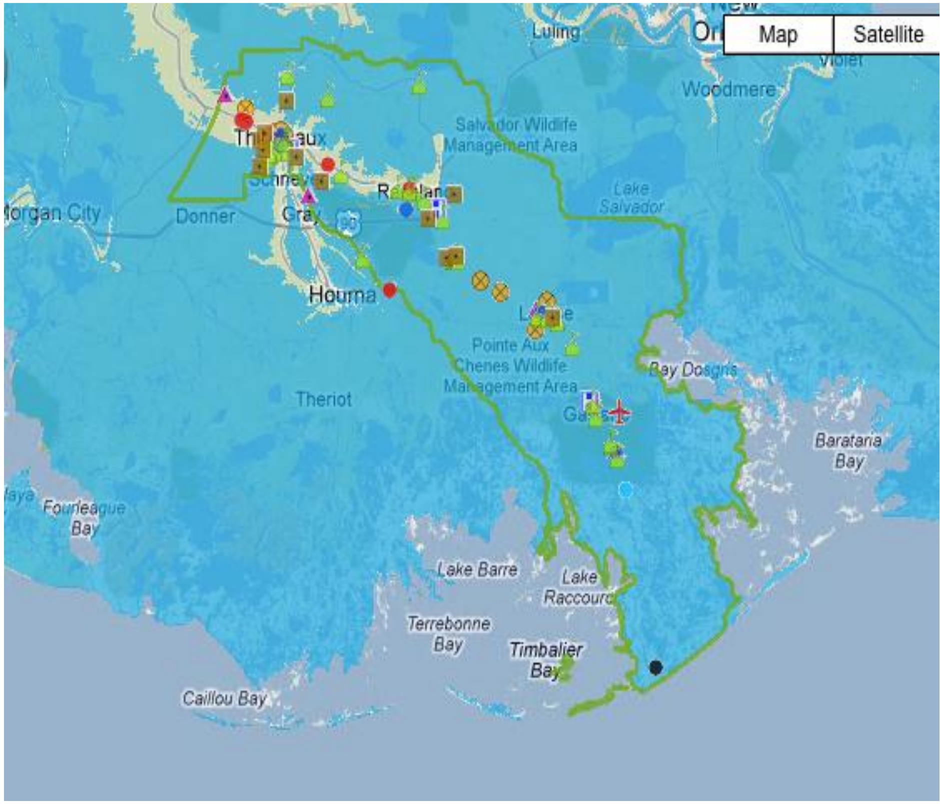
Critical Facilities: Flood Exposure Tool

Lafourche, LA Critical Facilities: In FEMA Flood Zone

- **Roads** 68% or 724 out of 1061

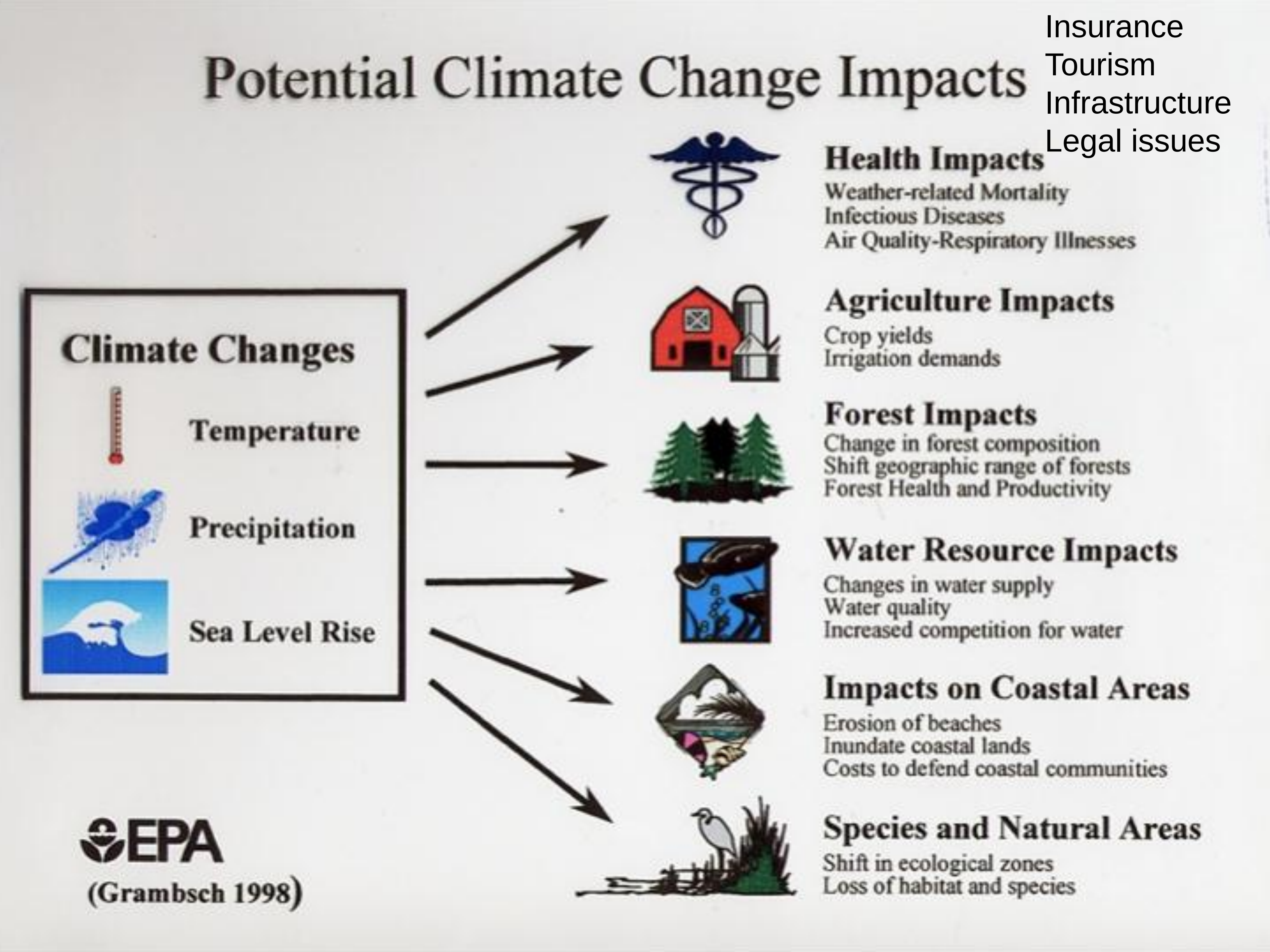
road miles* Based on 2005 ESRI/TeleAtlas Roads data

- **Critical Facilities**
- 1 airport * 4 communication
- 3 fire stations towers
- 3 hazardous materials sites
- 1 potable water treatment plants
- 1 oil facility * 2 hospitals
- 4 police stations
- 20 schools
- 8 waste water facilities



Lafourche Parish, Louisiana

- http://www.csc.noaa.gov/criticalfacilities/



Insurance
Tourism
Infrastructure
Legal issues

Key Messages

1. Climate change is here. We are already observing changes. (Big Picture – WHY you might care)

1. The future will be different than the past and there will be consequences for the region. (WHAT – local impacts)

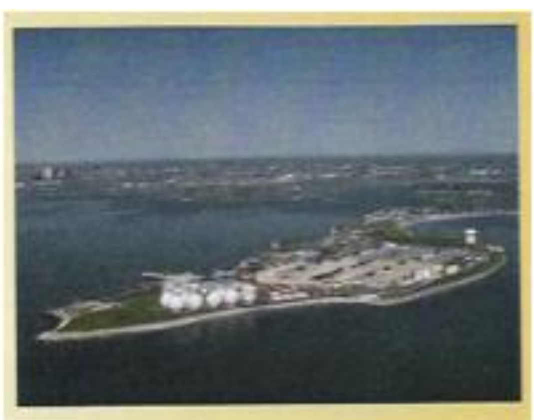
1. Decisions made today can help us to be better prepared for tomorrow. (HOW – local decisions)

Two Responses to a Changing Climate

Mitigation: reduce emissions; energy efficiency; alternative energies, etc.

Implementation: NOW and save money

Impacts on climate change: 50-100 yrs.



Adaptation: planning ahead; incorporating likely future climate states into regular planning; taking action; *Just Better Planning*

Implementation: NOW and in future

Impacts on community: Now and Future.

There is a 3rd possible response . . .

Community Context

Climate Change is not the only challenge to be juggled

We all have:

- A lot to lose from climate impacts: storms, water issues, health impacts, forest fires, etc.
- Limited resources and tight budgets: competition – economy, energy, environment, education
- Much to gain from opportunities: economic dev., energy savings, avoided costs, green and problem specific jobs
- Relevant authorities: tools to use [comprehensive plans (influence land use); zoning/subdivision ordinances (types of uses and density); blgd and dev permits (what, where, how, how many), building codes (specific req), spending powers (strategic placement of infrastructure); incentives (smart growth/bonuses/preservation)]
- Opportunity to learn from/work w/other communities and disciplines

Adaptation (aka Mitigation)

- No "top 10" Adaptation Actions
- Adaptations are location and issue specific
- Adaptive capacity is uneven w/in & across society: resources ($, info., expertise); political will; stringent policies and regulations; cultural acceptability; what do people know and understand?; not automatically translate into reduced vulnerability
- Scale of info must match scale of issue
- Rarely *only* because of climate change: multiple stressors (e.g. growing populations in harms' way); hazard management
- Climate change - a moving target: requires continuous reassessment

Coastal Adaptation options/examples

Responding to Sea-Level Rise and Storm Surge

- Protect: build hard structures such as levees and dikes (although this can actually increase future risks by destroying wetlands and also by creating a false sense of security that causes more development in vulnerable areas)

- Accommodate rising water: elevate roads, buildings, and facilities; improve flood control structure design; enhance wetlands (Restoration: important for natural areas)

- Retreat: accommodate inland movement through planned retreat; setbacks for construction; improve evacuation planning; restore wetlands

Courtesy of Jack Pellette, NWS

Responding to Sea-Level Rise and Storm Surge

- Protect: build hard structures such as levees and dikes (can increase future risks by destroying wetlands and creating a false sense of security causing more development in vulnerable areas)

Courtesy of Jack Pellette, NWS

Flooding: Sea-Level Rise/Fresh Water

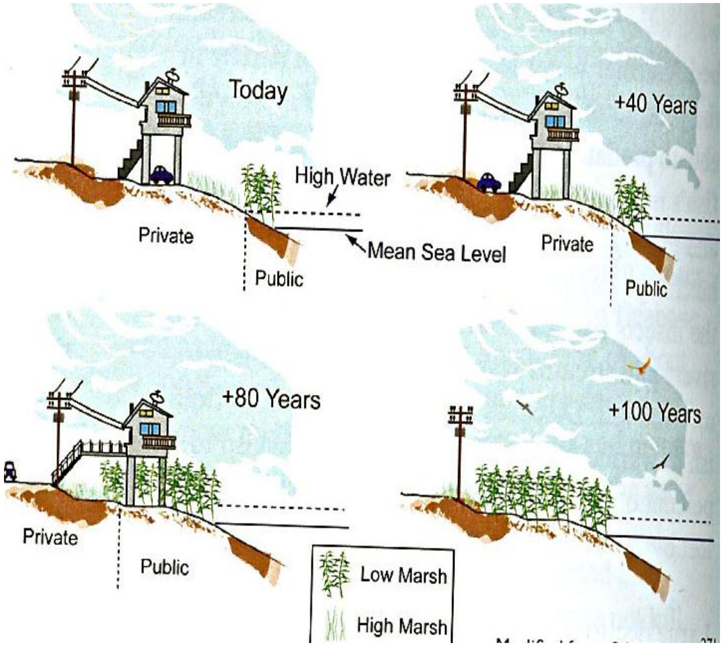
- Accommodate rising water: elevate roads, buildings, and facilities; improve flood control structure design (e.g. larger culverts; flapper valves); enhance wetlands (important for natural protection)

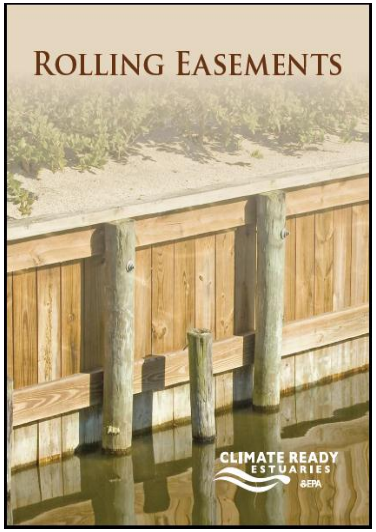
http://www.lumcon.edu/facilities/fourchon/
House in Cocodrie, LA

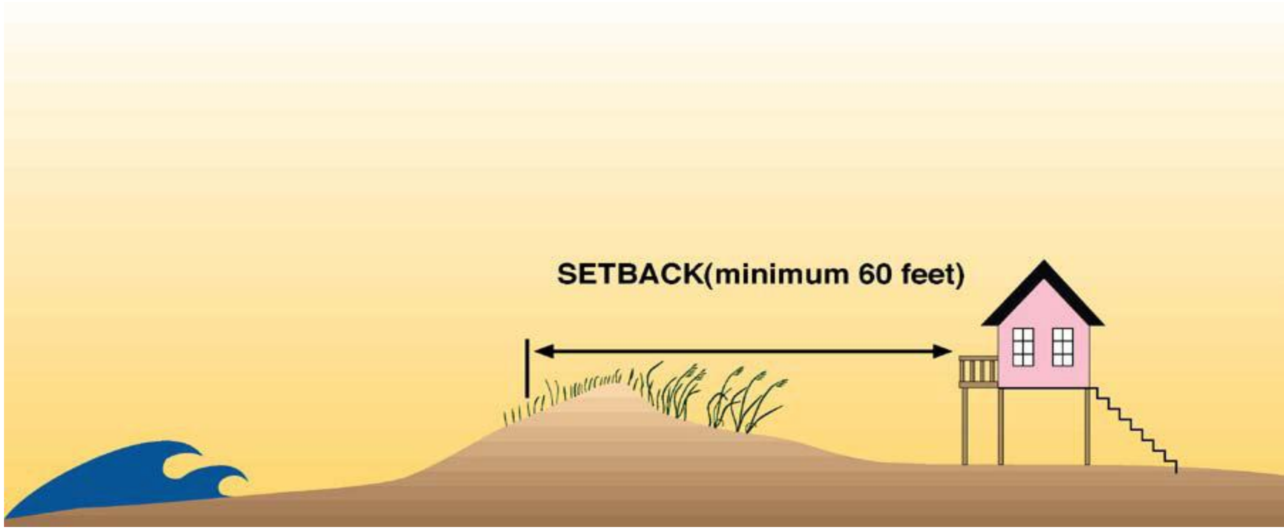
Marine Science Ctr, Aransas, TX

Responding to Sea-Level Rise and Storm Surge

Retreat: accommodate inland movement through planned retreat; setbacks for construction based on erosion rates; no armoring; small structures; clear expectations for development; rolling easements; improve evacuation planning; restore wetlands: for fresh water – establish/maintain fresh water buffer areas







USGCRP 2009 and US EPA

Rapid City, SD

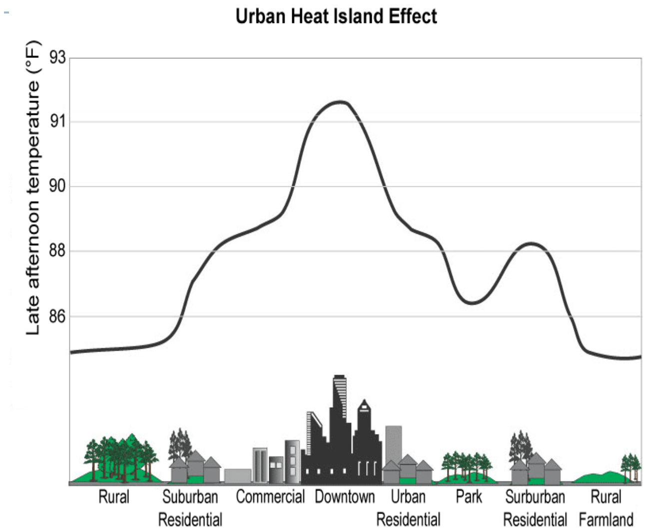
Omaha St: before the June 9, 1972 flood – residential and commercial

Omaha St. after the flood – parks and golf courses

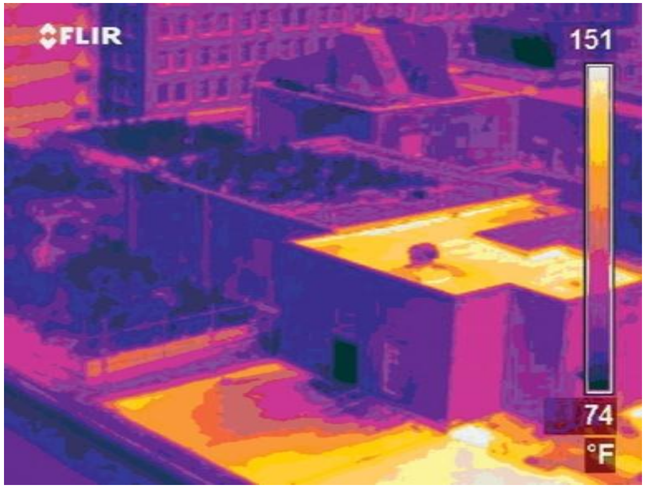
Photos from Digital Library of S. Dakota

Adaptation example: Heat waves

- Local weather service issues heat alerts
- Provide tips on how vulnerable people can protect themselves
- Use buddy system to check on elderly residents
- Public utilities voluntarily refrain from shutting off services for non-payment
- Extend hours for public cooling places



- Install reflective or green roofing and plant trees in urban areas to help cool urban heat island



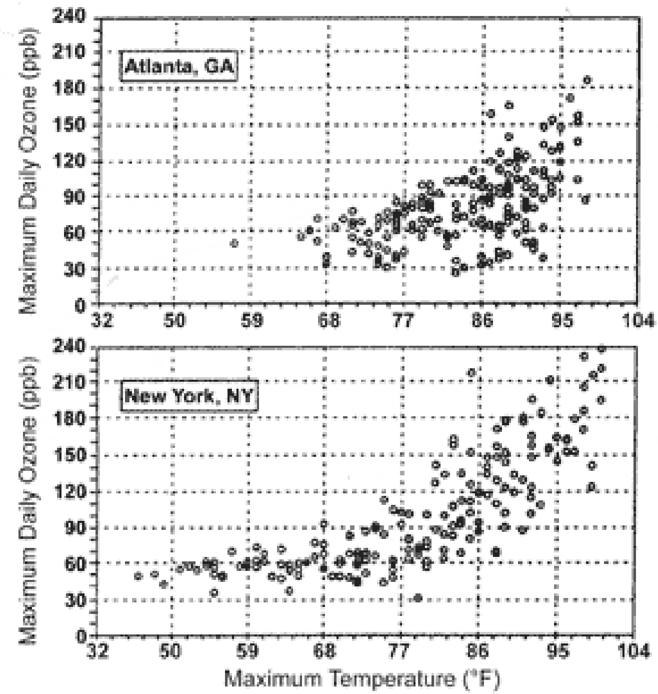
"Green roofs" are cooler than the surrounding conventional roofs.

From: Global Climate Change Impacts In the US, 2009

Adaptation example

Improving Urban Air Quality

- Refuel vehicles after dark
- Encourage mass transit use by offering free rides on Air Quality Alert Days
- Encourage residents to limit car travel, especially during day
- Conserve energy
- Avoid outdoor burning



From: Global Climate Change Impacts In the US, 2009

Adaptation examples

Agriculture

- Switch to plant species that mature earlier and are more resistant to heat and drought
- Alter planting dates
- Increase crop and livestock diversity
- Minimize need for external inputs such as irrigation

Fire due to drier conditions

- Thin trees and bushes near structures
- Select ignition-resistant building materials and design features
- Position structures away from slopes
- Develop emergency plans and evacuation procedures

From: Global Climate Change Impacts In the US, 2009

Other Adaptation examples

Declining water resources

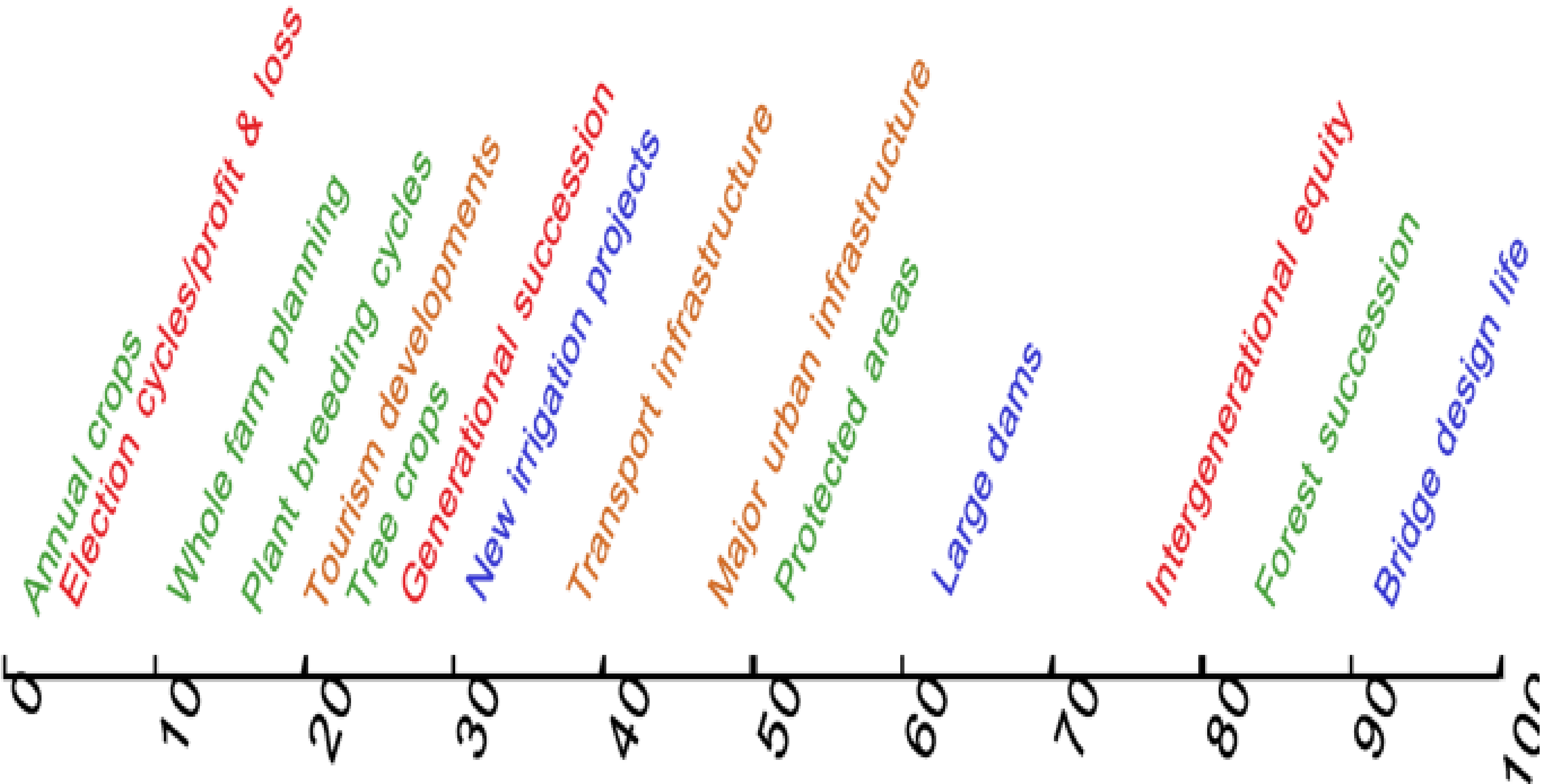
- Increase public awareness
- Encourage water conservation
- Fix water distribution systems to minimize leakage
- Increase freshwater storage capacity
- Explore alternative sources including importing water, desalinating seawater, and using treated wastewater

Unmanaged ecosystems

- Establish baselines for ecosystems and their services
- Identify thresholds
- Monitor for continued change
- Restore ecosystems that have been adversely affected
- Identify refuge areas that might be unaffected by climate change and can be preserved
- Relocate species to areas where favorable conditions are expected to exist in the future

From: Global Climate Change Impacts In the US, 2009

Adaptation Planning: Many Timeframes



Source: Linda Mearns, UCAR

When To Act?

Pro-action or Reaction
Inaction or Action
all have consequences/costs

- Road Crossing *Upgrade* estimate \$56,000
- Engineer's estimate to *Repair* Road \$93,000

Whitcomb Mill Road, NH

From M. Simpson, Antioch University

Infrastructure in disrepair…

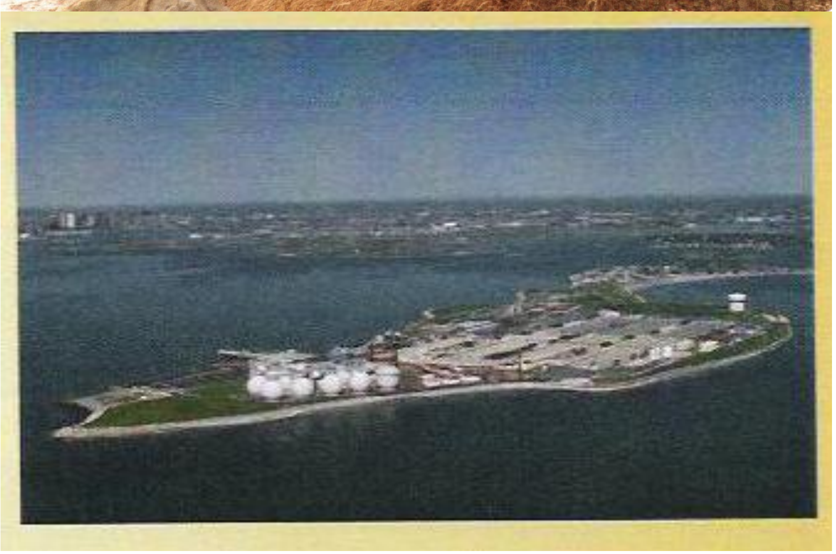
…to be repaired for a different climate future

From: Jim Buizer

Adaptation: Reframing the things we do every day

- Managers make decisions with imperfect information all the time – why is climate change different?
- Adaptive management – deliberate learning by doing
- Co-benefits – justify action by addressing additional priorities (e.g. reducing repetitive losses)
- Small institutional and legal changes can make a big difference (e.g. eliminating conflicting mandates)
- Potential for partnerships and economic opportunity
- An excuse to do things that make sense anyway, integrated planning, changes to the National Flood Insurance program, etc.

We can anticipate, plan ahead, act …



OR we can react.

Southern Climate Impacts Planning Program

- **Southern Climate Impacts Planning Program**: NOAA/RISA, LSU and OU, State Climatologists, Southern Regional Climate Center (website: www.southernclimate.org)

- Stakeholder-driven research: regionally relevant scientific research that results in critical information, products, tools, and education

- Engagement: partners, decision makers, and other stakeholders

- Southern U.S.: TX, OK, MS, LA, AR, TN

- Focus multi-hazard preparedness: severe storms, droughts, floods, hurricanes, extreme temperatures, etc., and coastal impacts of climate change and variability.

Questions?

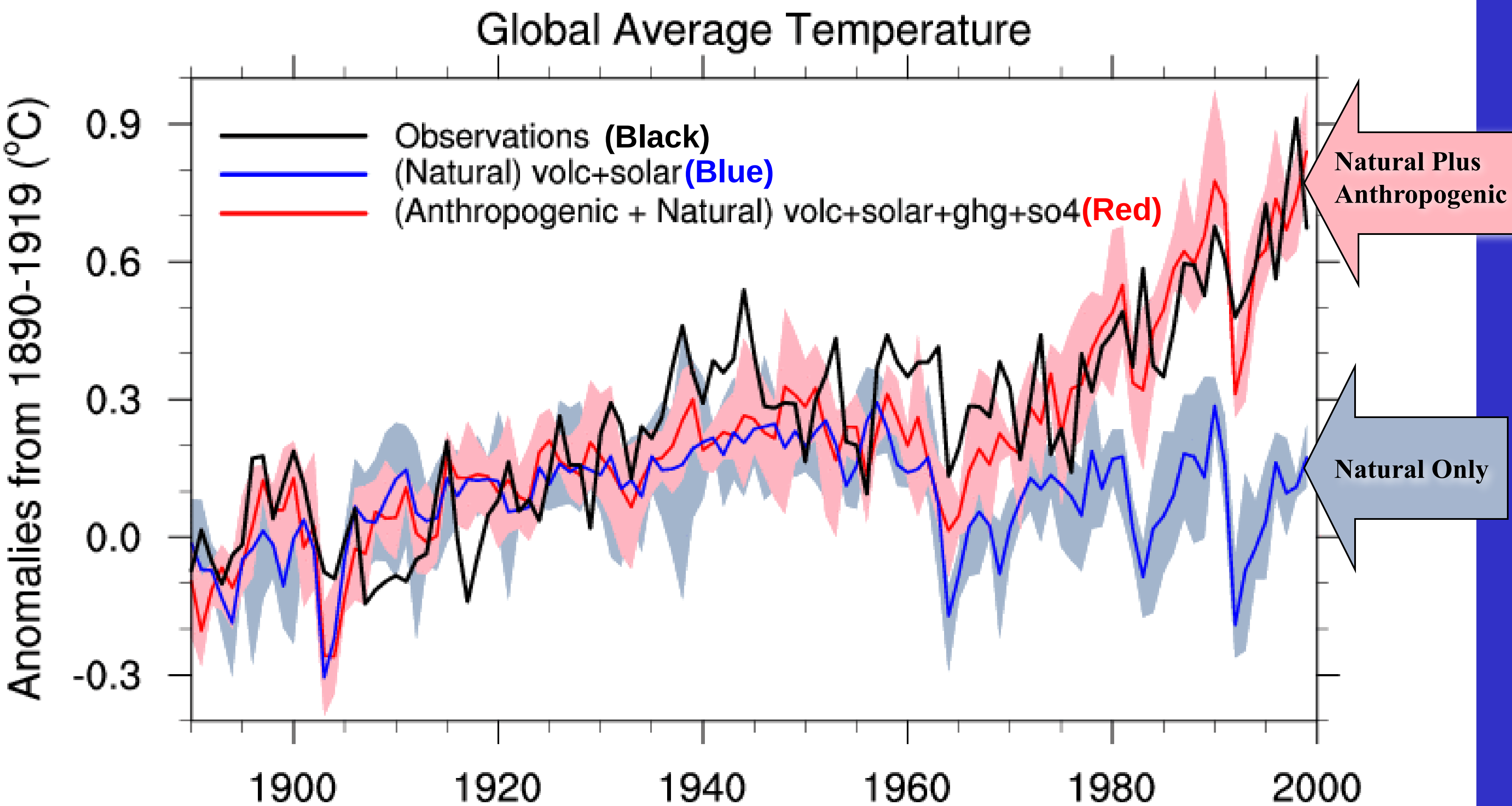
Lynne M Carter
email: lynne@srcc.lsu.edu
225 578-8374
http://www.southernclimate.org (data products)

Resources:

- 2009, Global Climate Change Impacts in the United States

  http://library.globalchange.gov/products/assessments/2009-national-climate-assessment
- NOAA – climate.gov – many informative resources e.g. Coastal Climate Adaptation database
- EPA, NASA, NSF – all have resources on their websites
- For Adaptation Examples:
  1. Georgetown Climate Center Adaptation Clearinghouse *www.georgetownclimate.org/adaptation/clearinghouse*
  2. Climate Adaptation Knowledge Exchange *www.cakex.org*
  3. Ecosystem Based Management *http://www.ebmtools.org/*

How well are the models depicting the last 100 years?



NCAR Climate Simulations