LONGWOOD GARDENS

March 29, 2017

Caring for Trees in a Changing Climate

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US Forest Service

Impacts of Climate Change on Trees and Ecosystems in the Delaware River Valley

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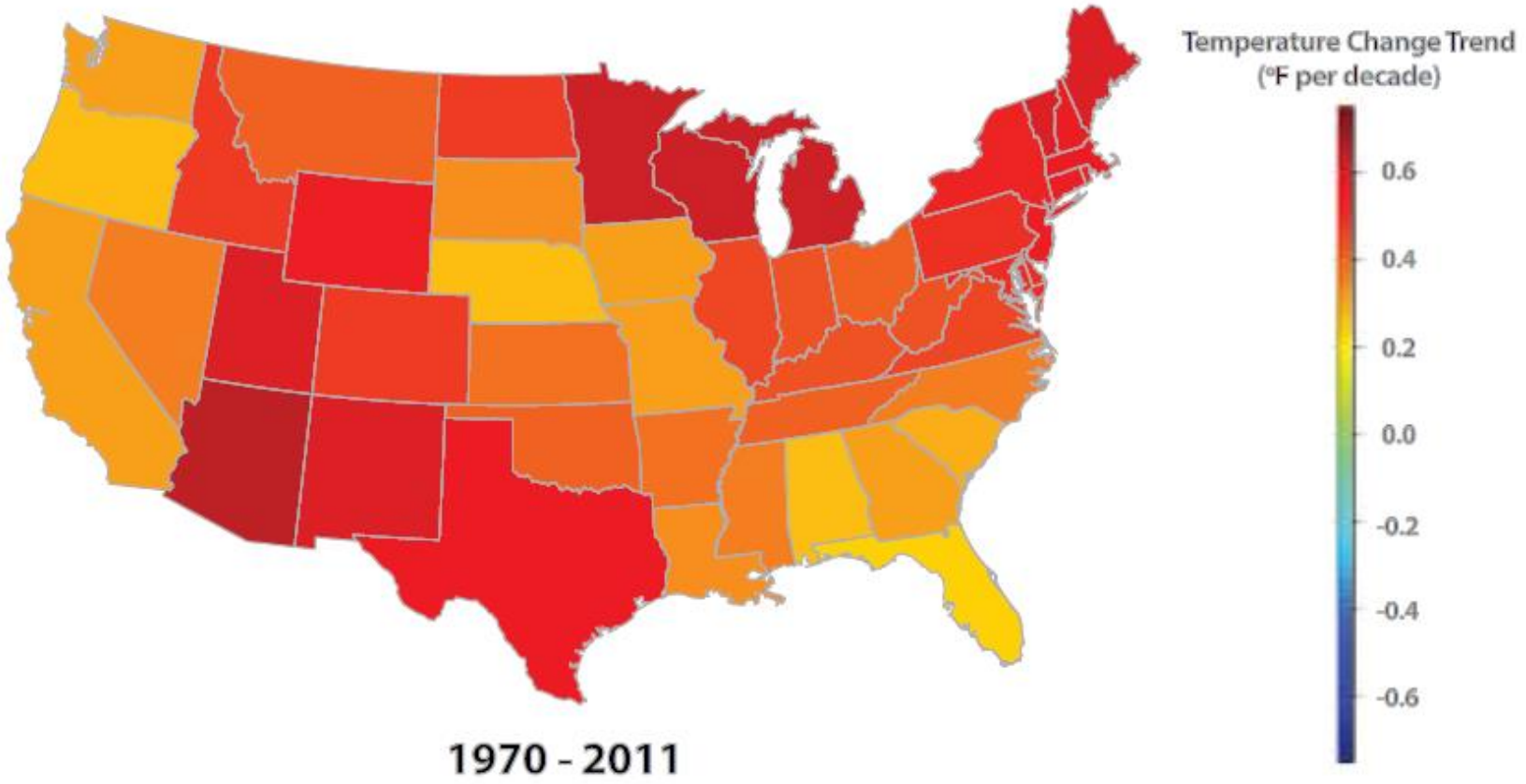
Local observations



Tebaldi et al. www.climatecentral.org

Temperature Changes

- Mean Annual temperature increase of 2-3°F
- Greatest warming in the winter
- More warming on the coast

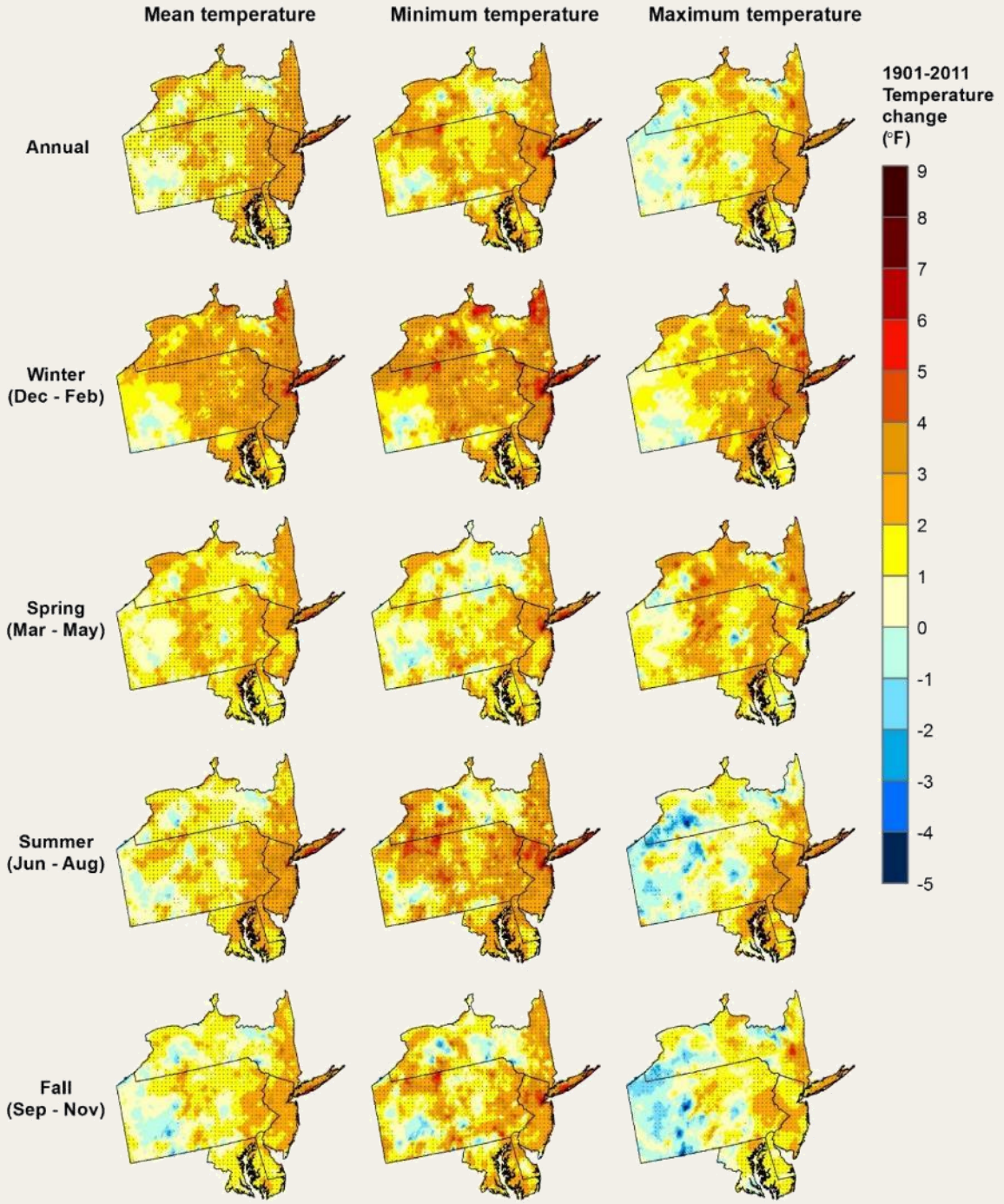
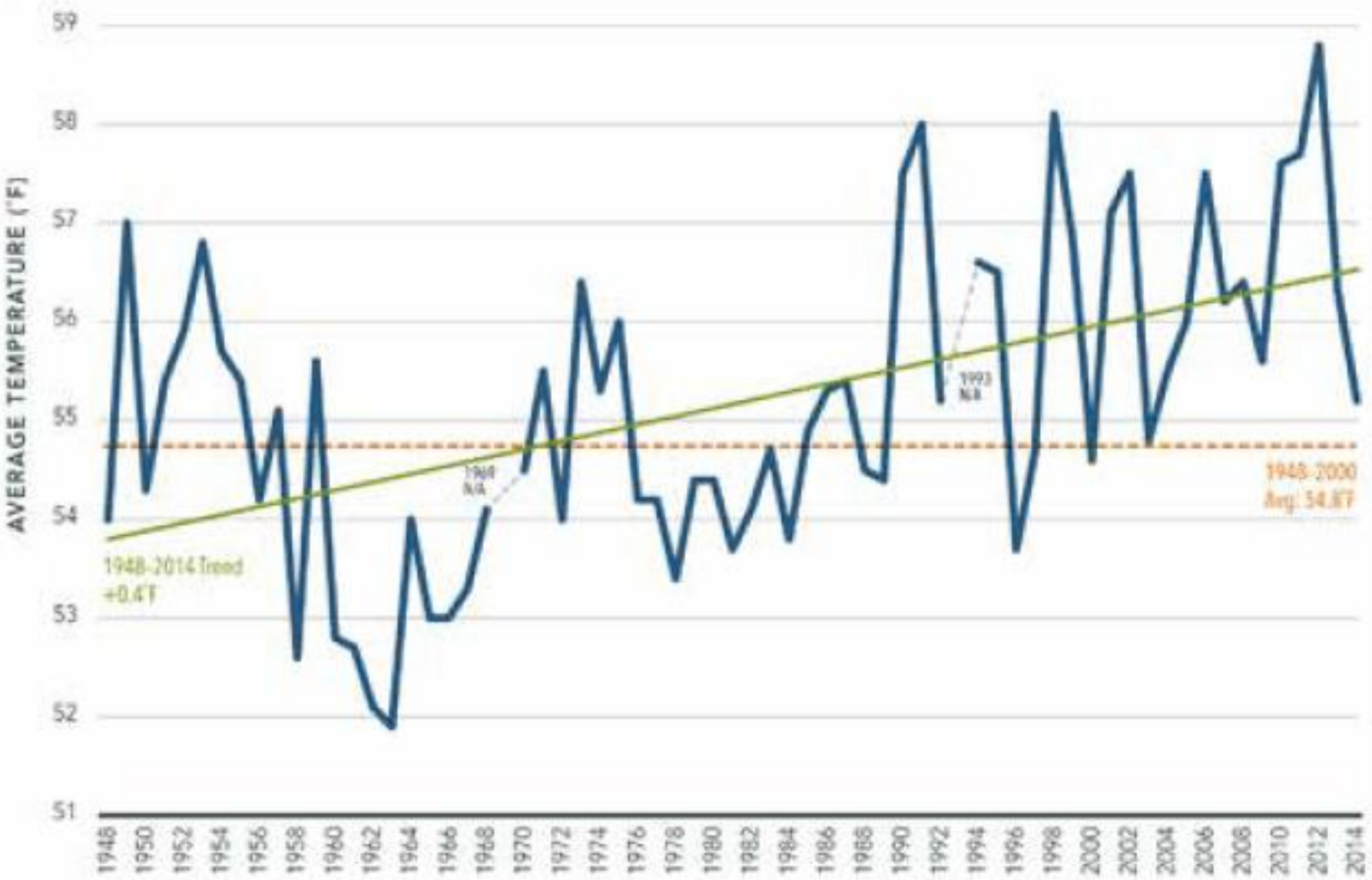


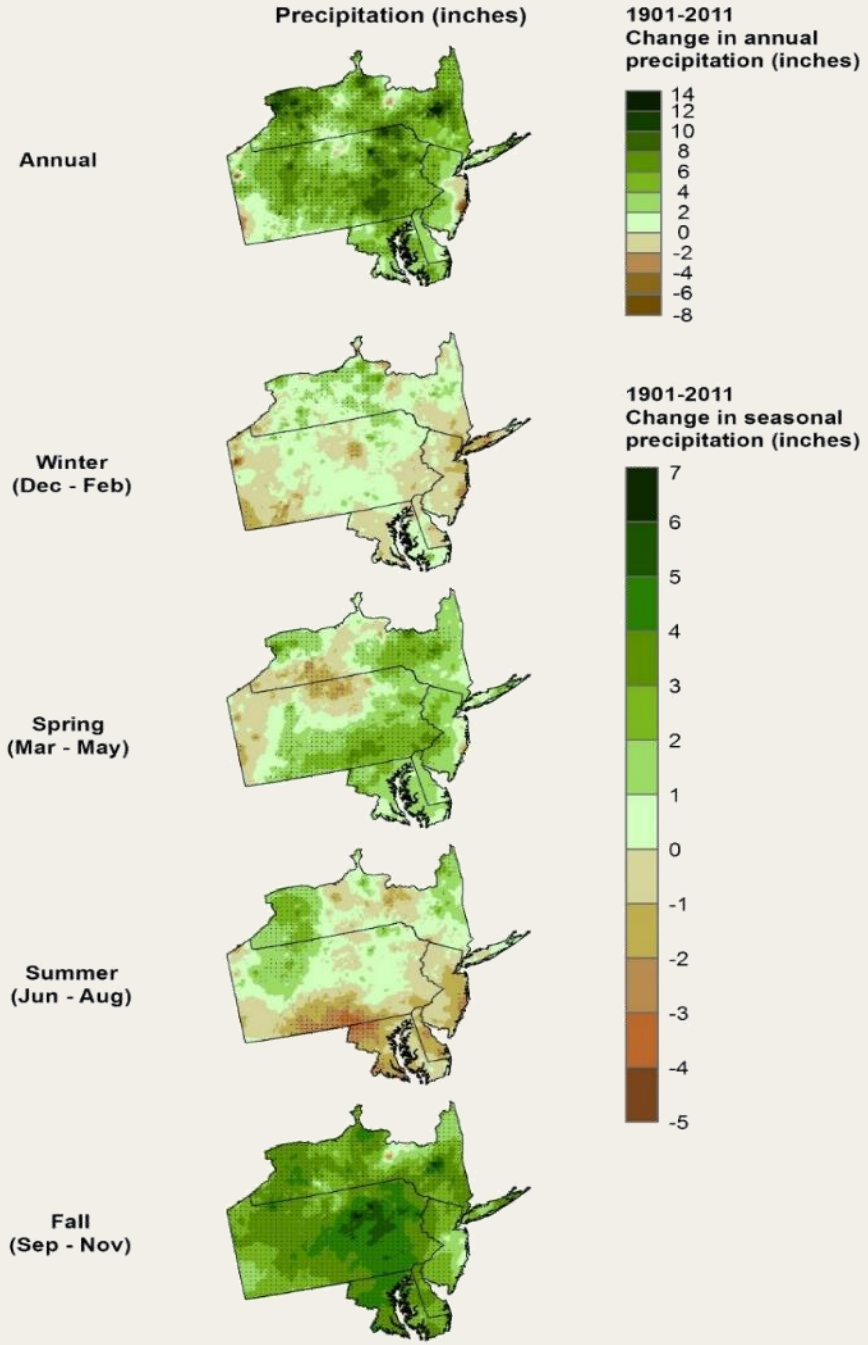
FIGURE 1

ANNUAL TEMPERATURE TREND FOR PHILADELPHIA, 1948–2014



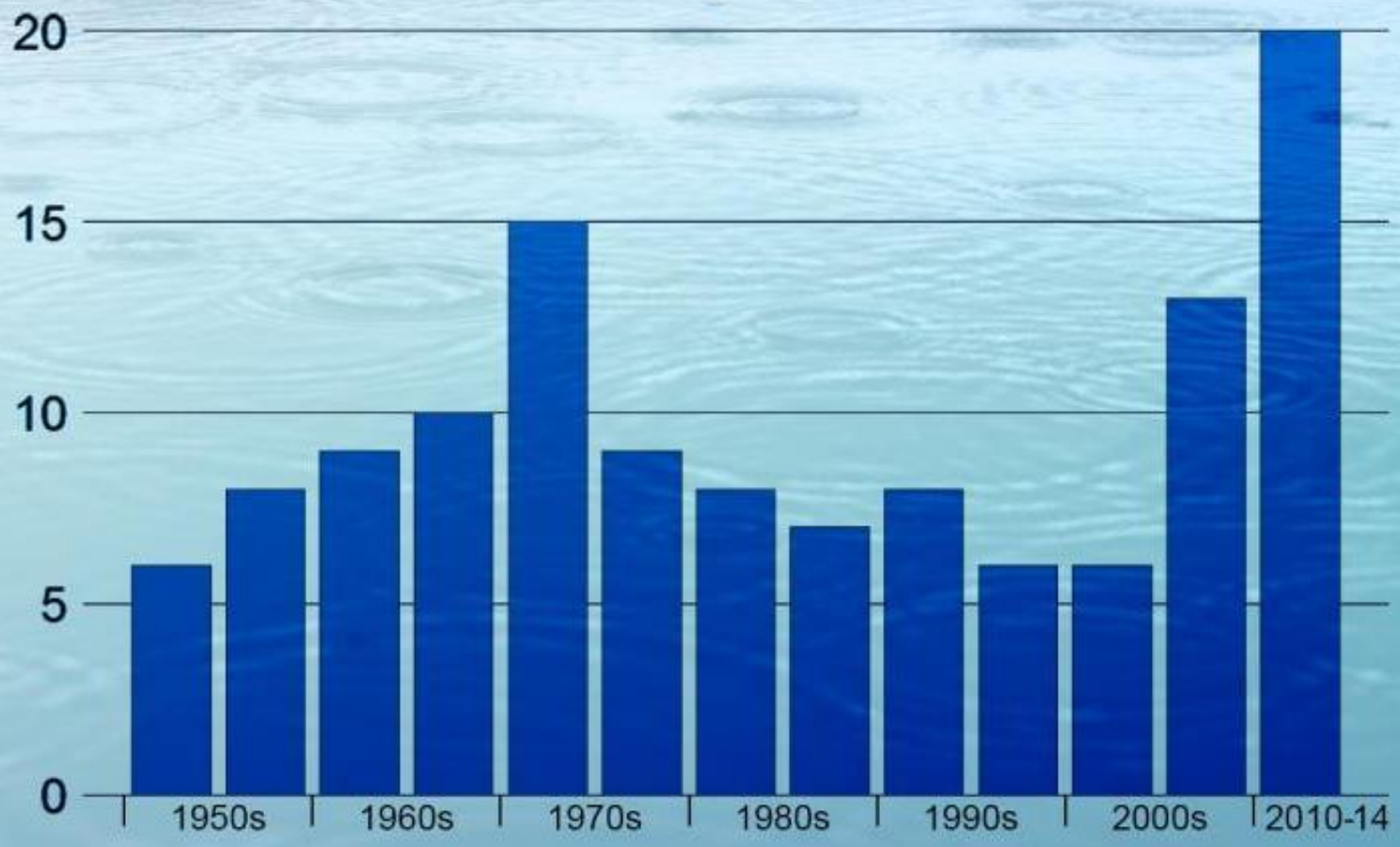
Precipitation Changes

- More annual precipitation
- Little change in winter precip.
- Spring is wetter
- Summer slightly drier
- Fall much wetter



HEAVY PRECIPITATION

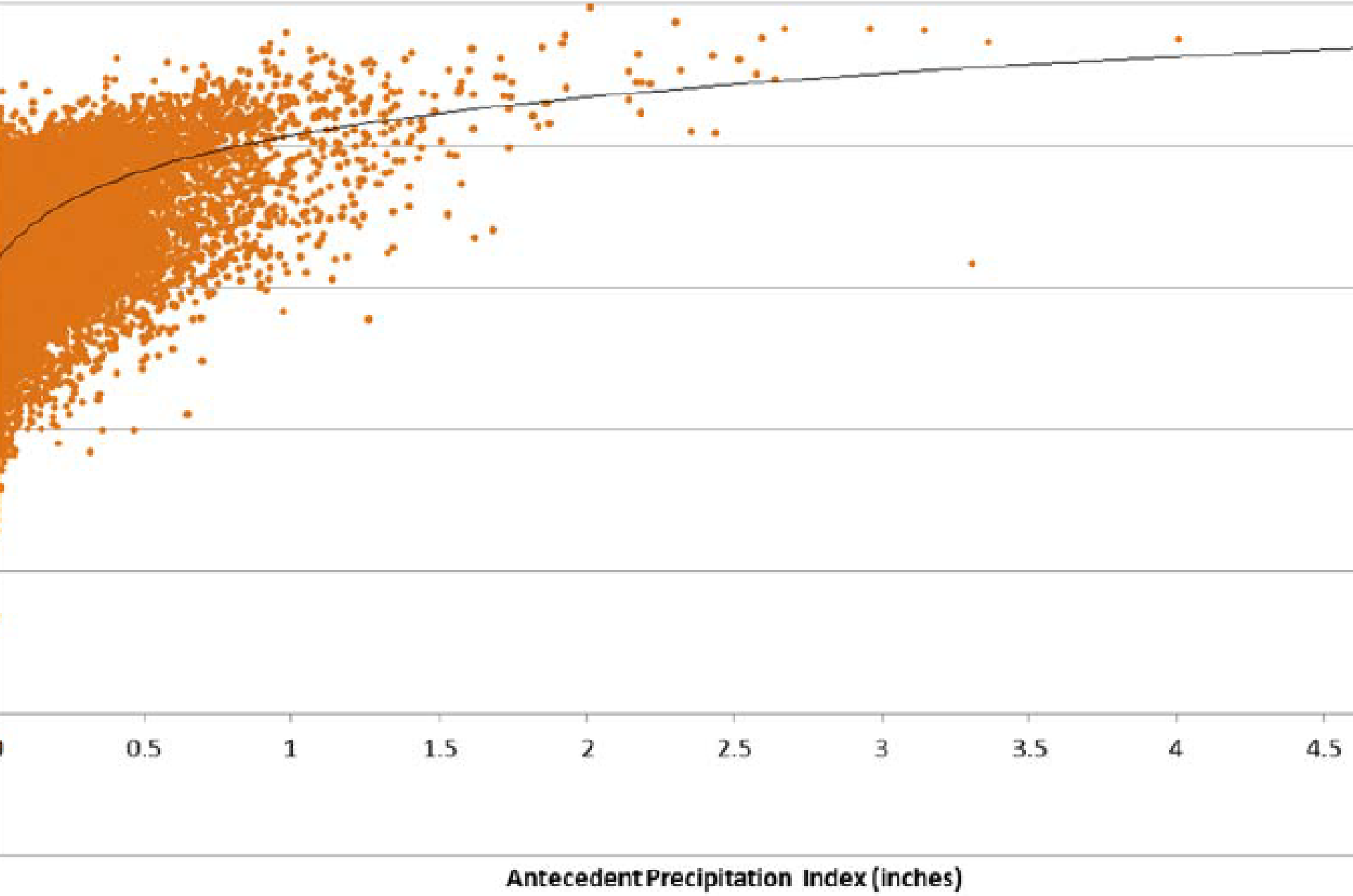
Philadelphia / Days with 2" or More



1950 through 2014. Each bar represents a 5 year total.
Source: Applied Climate Information System (rcc-acis.org)

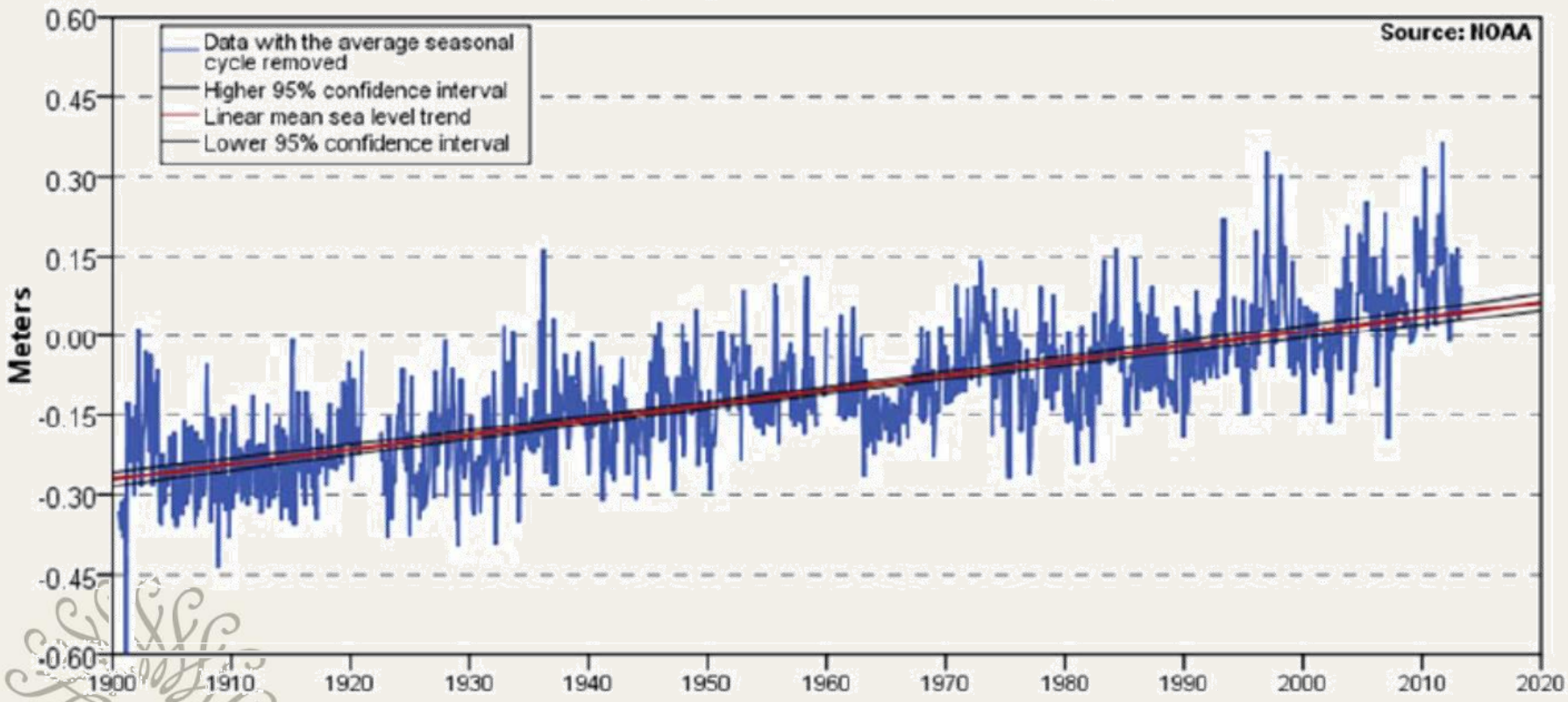
CLIMATE CENTRAL

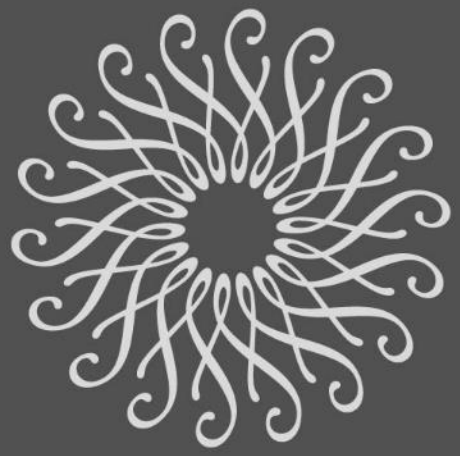
Figure 4 – Correlation of Antecedent Precipitation Index and Daily Mean Discharge (1949-present)



Sea Level is Rising

Figure 5 – Mean Sea Level Trend in Philadelphia (NOAA Tides and Current, 2014)





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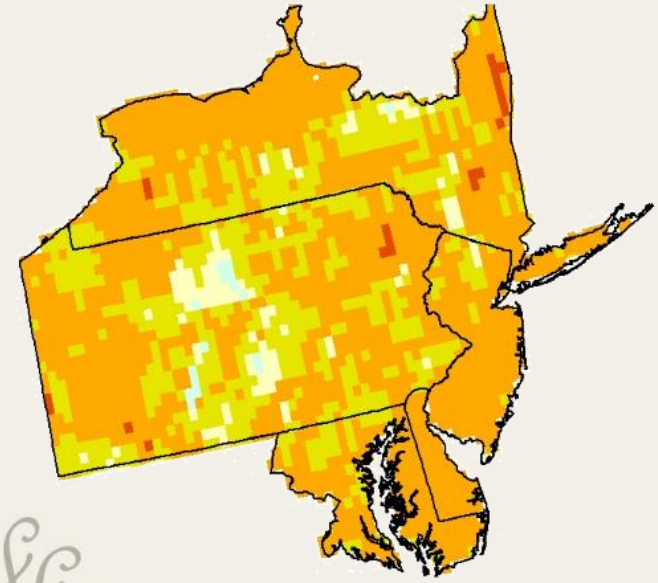
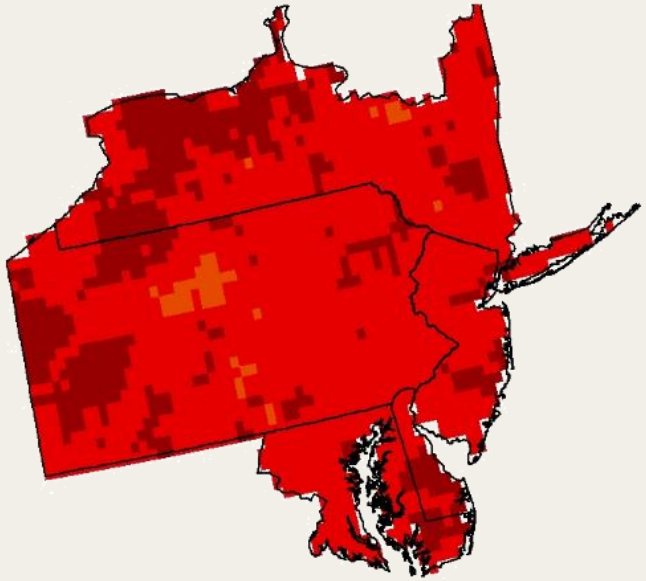
Local projections

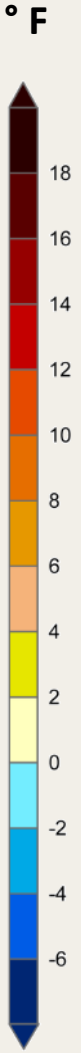
Warmer mean annual temperature

Low Emissions



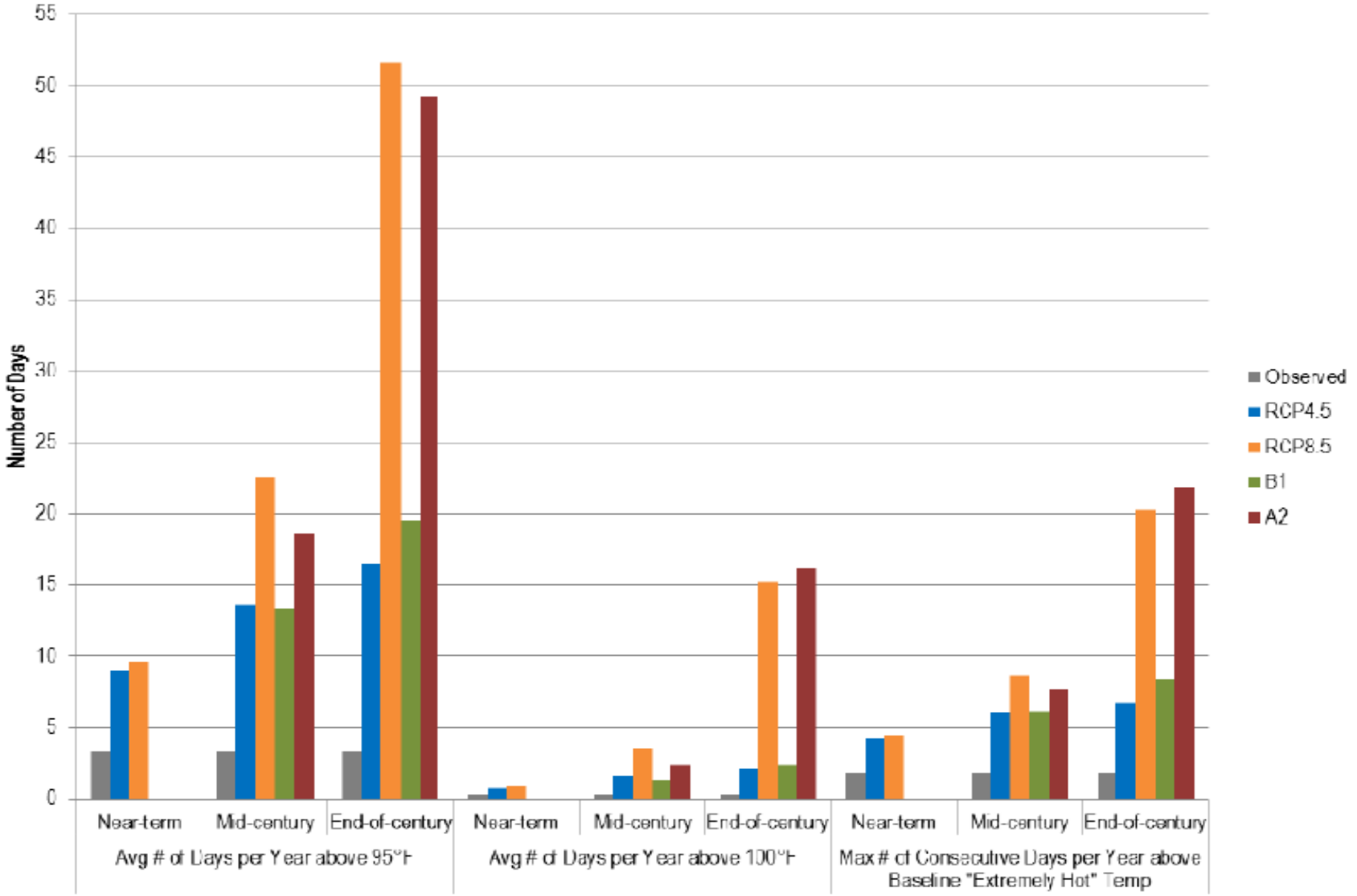
High Emissions





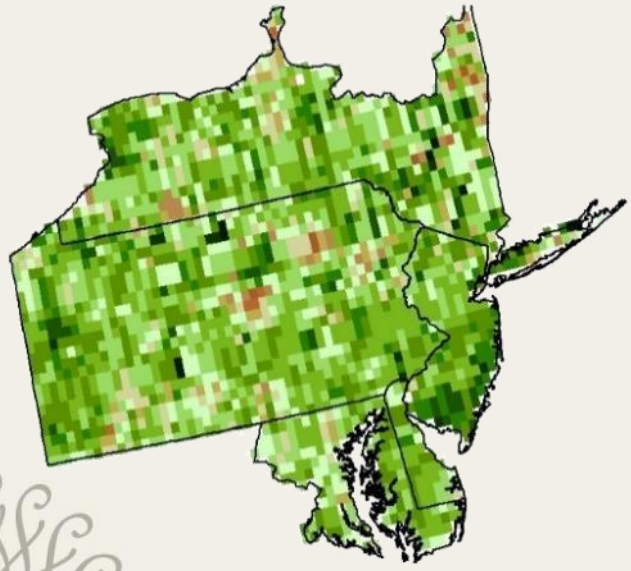
More Hot Days

Figure 2 – Projected Temperature Extremes in Philadelphia

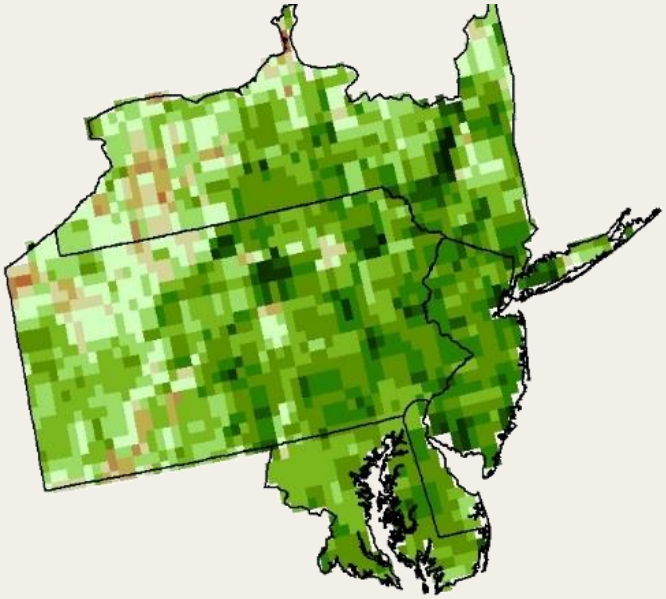


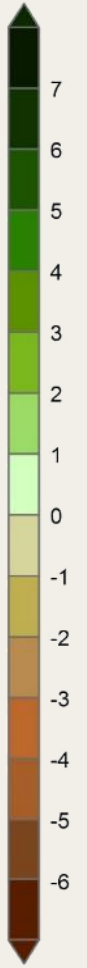
More Precipitation

PCM B1

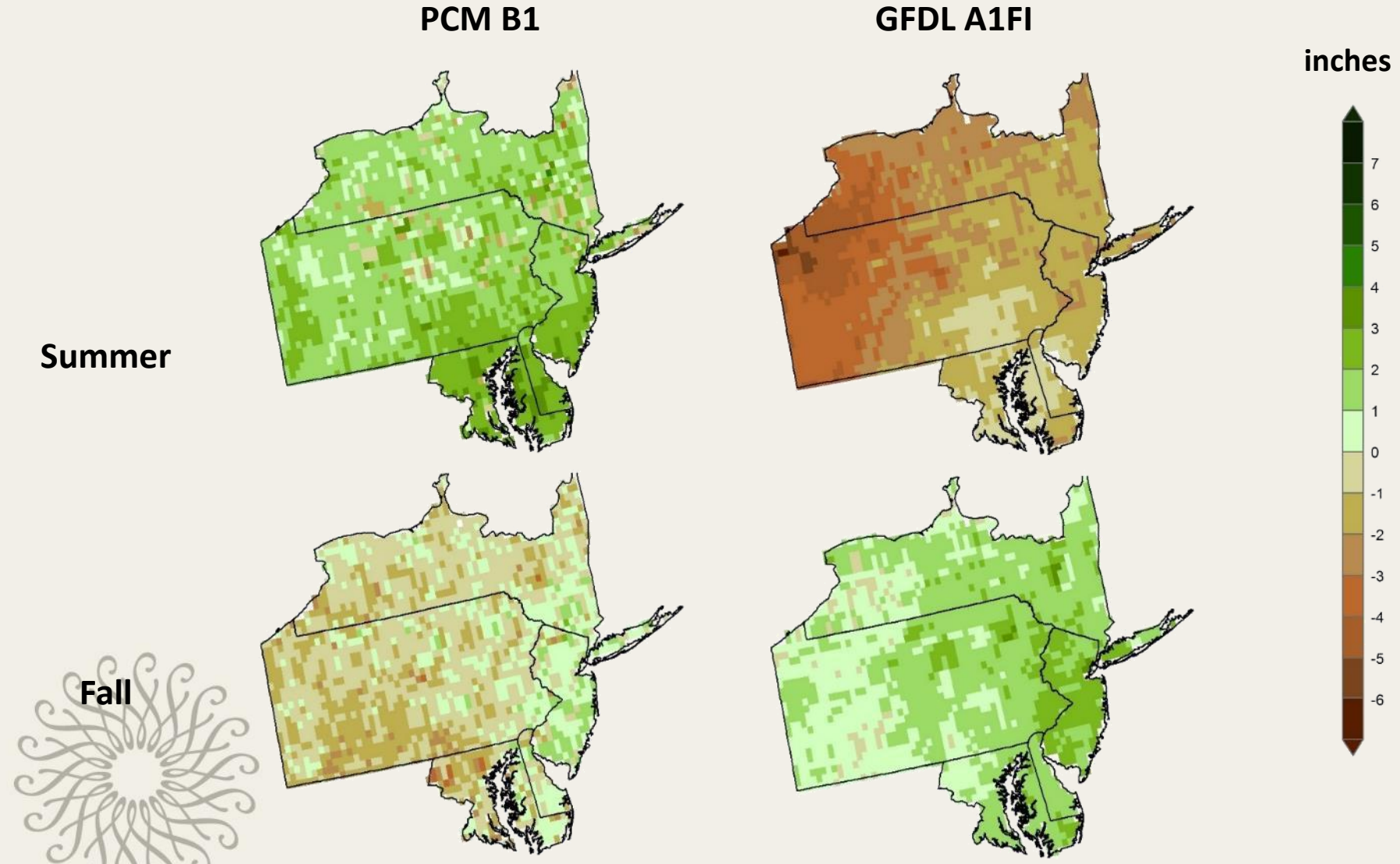


GFDL A1FI

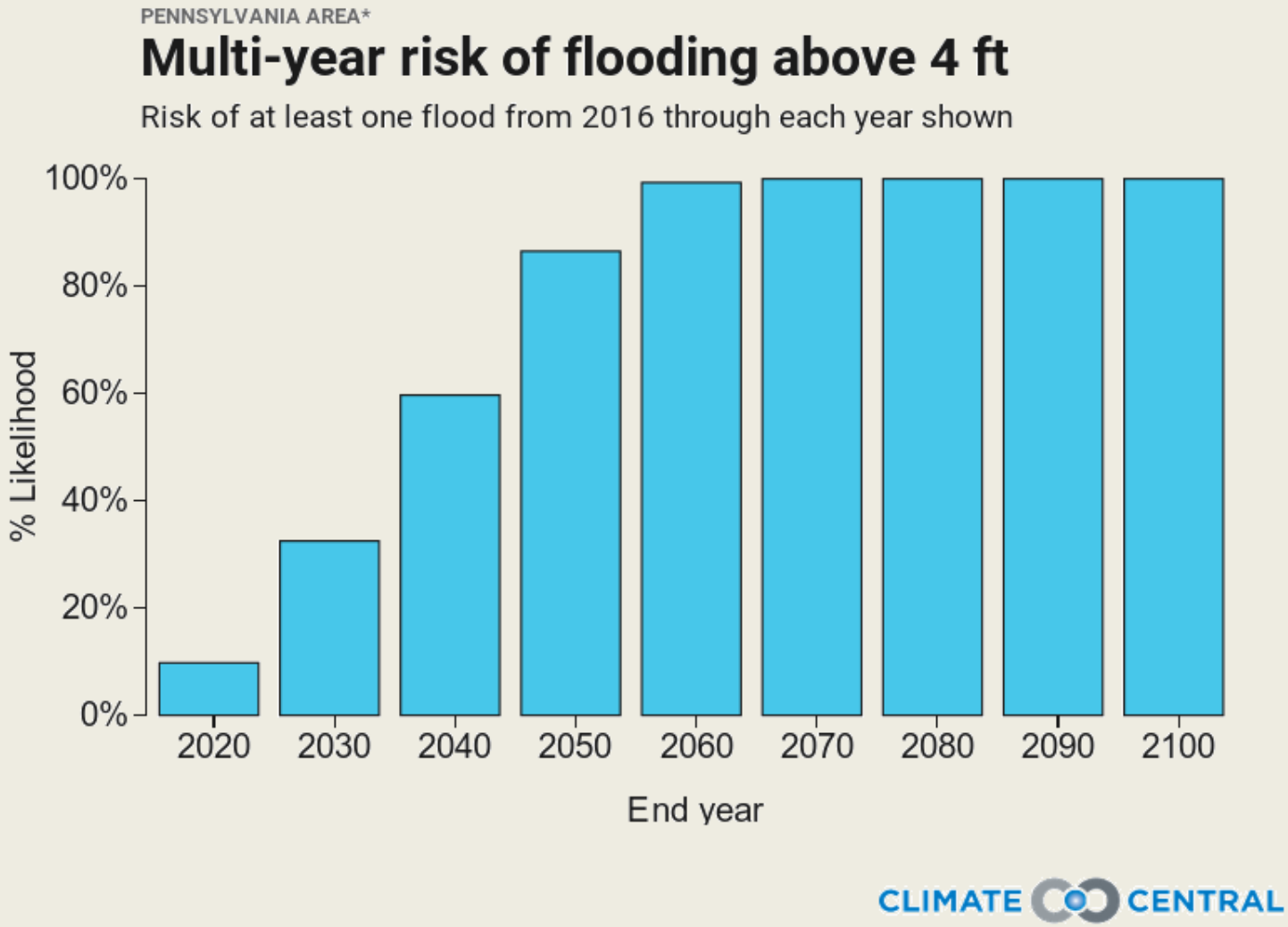




Seasonal Precipitation

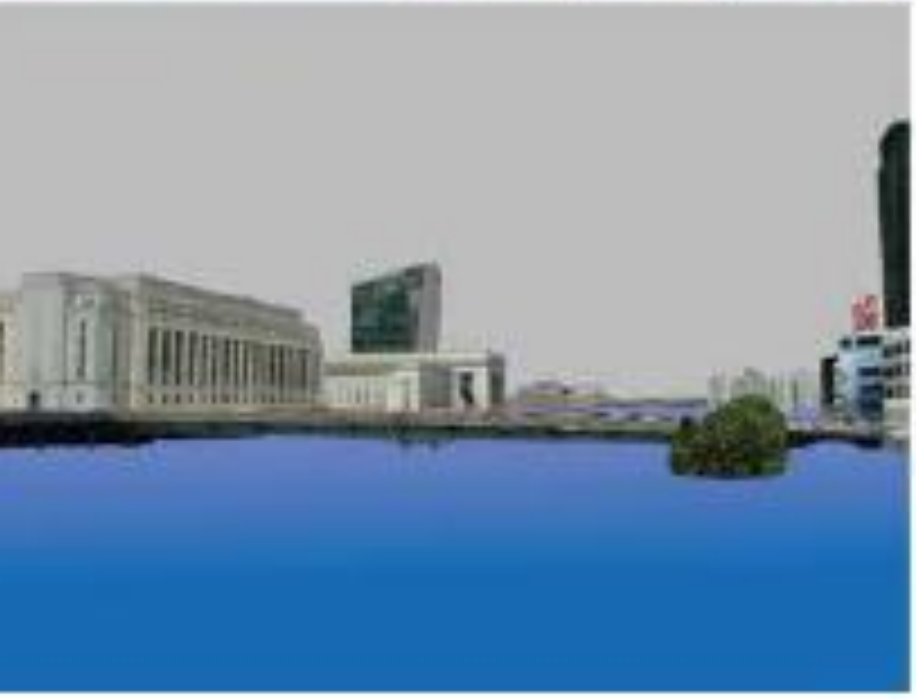


Sea Level Rise



Nearly 9 square miles of land lie less than 4 feet above the high tide line in Pennsylvania.



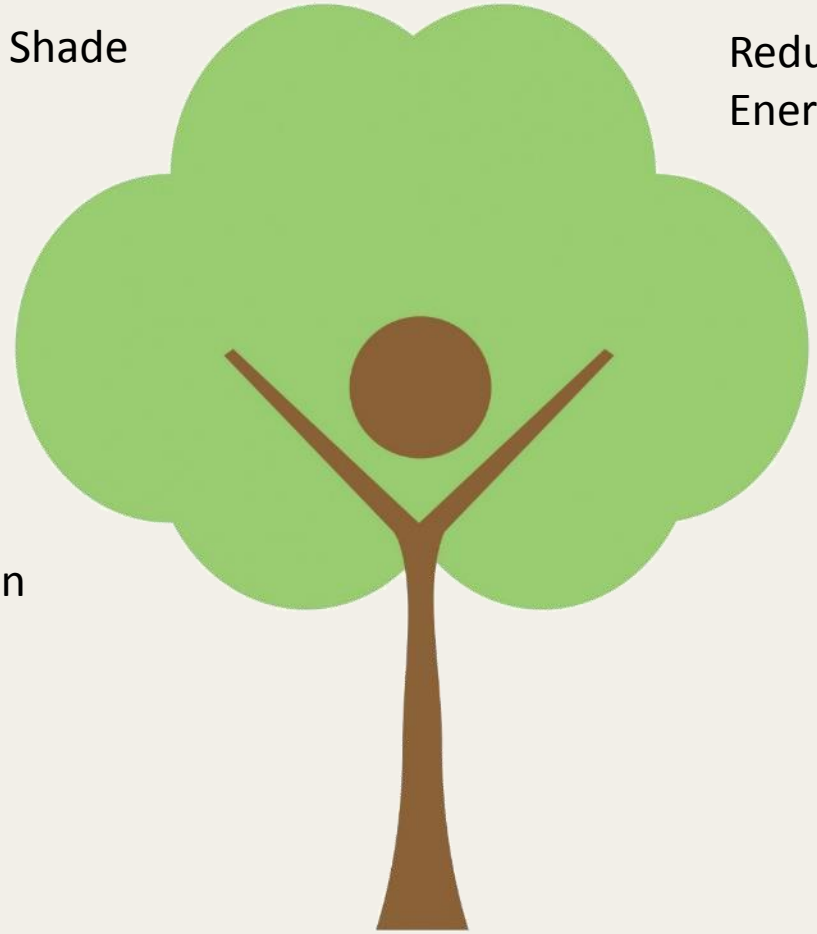



Benefits of Trees in a Changing Climate

Provide Cooling and Shade

Reduce Heating and Cooling Energy Use

Improve Air Quality



Control Stormwater

Take Up Carbon Dioxide

…But, Climate Change Can Create Challenges for Trees

Steps to Getting Your Trees Climate-Ready

1. Know your local impacts
2. Understand how trees may respond differently
3. Assess your options to adapt
4. Take action

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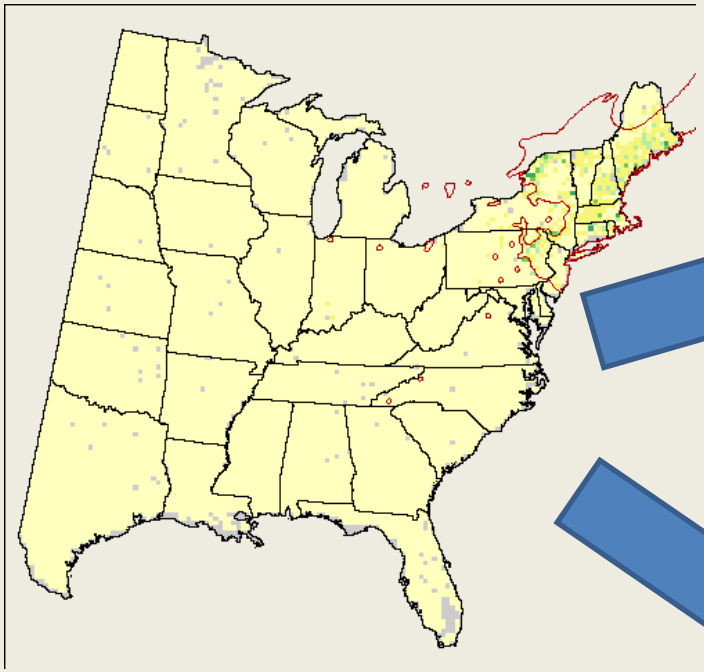
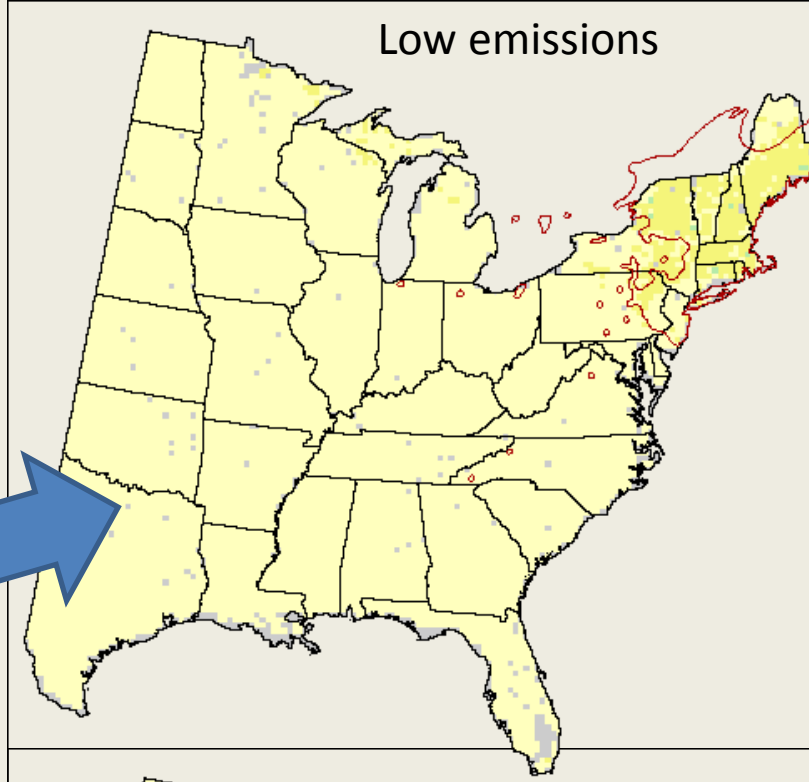
Implications for Trees and Forests

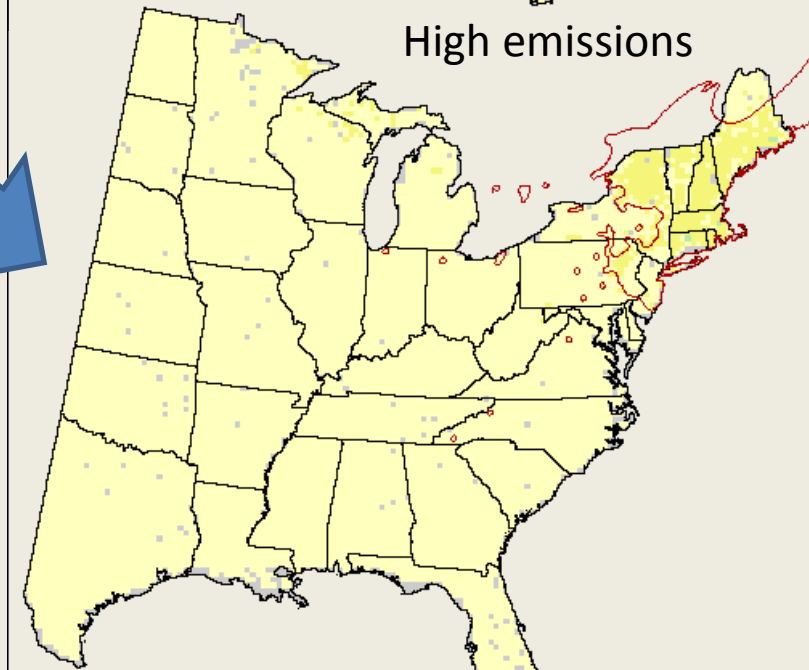
Climate Change Tree Atlas

- Web-based tool developed by Dr. Louis Iverson and the Landscape Change Research Group
- Shows maps of statistically-modeled changes in suitable habitat
- 134 tree species
- www.fs.fed.us/nrs/atlas/

Gray Birch





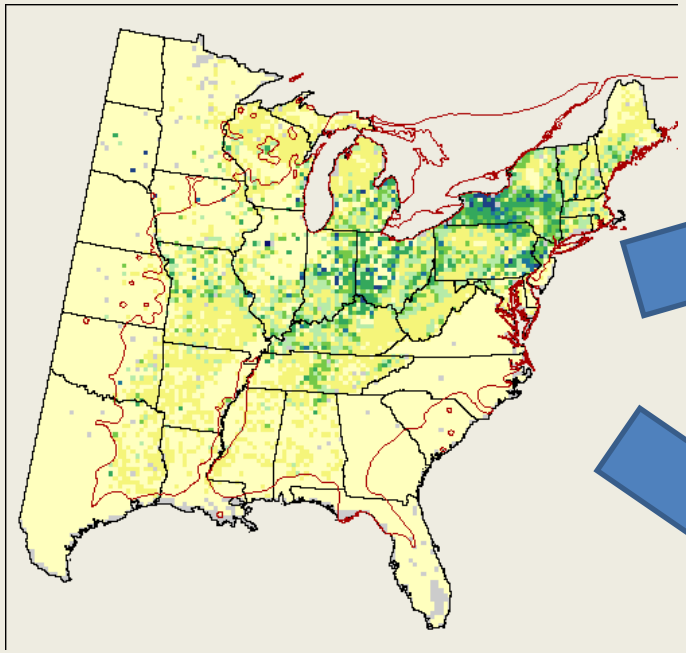


Little's Range

Importance Value

- 0
- 1 - 3
- 4 - 6
- 7 - 10
- 11 - 20
- 21 - 30
- 31 - 50
- > 50
- No Data

White ash



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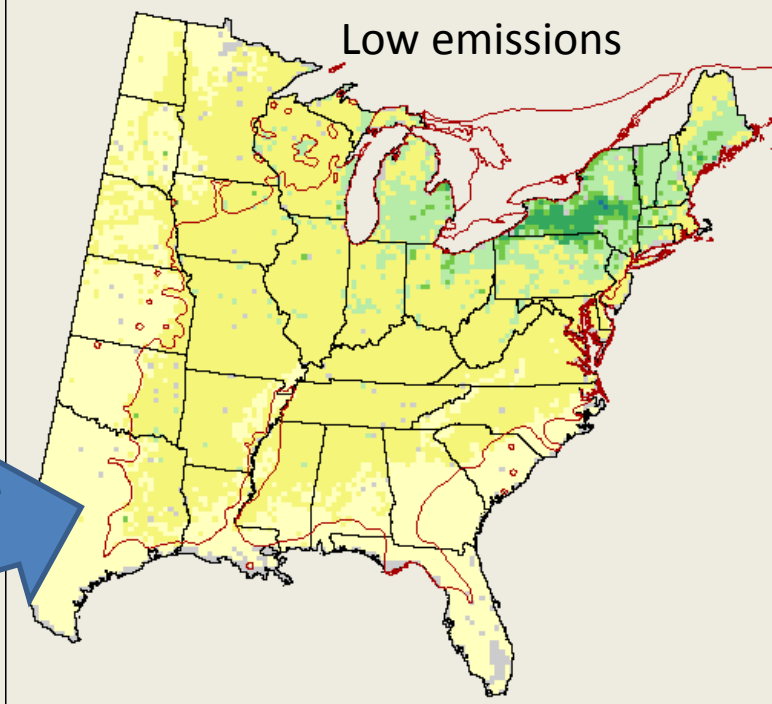
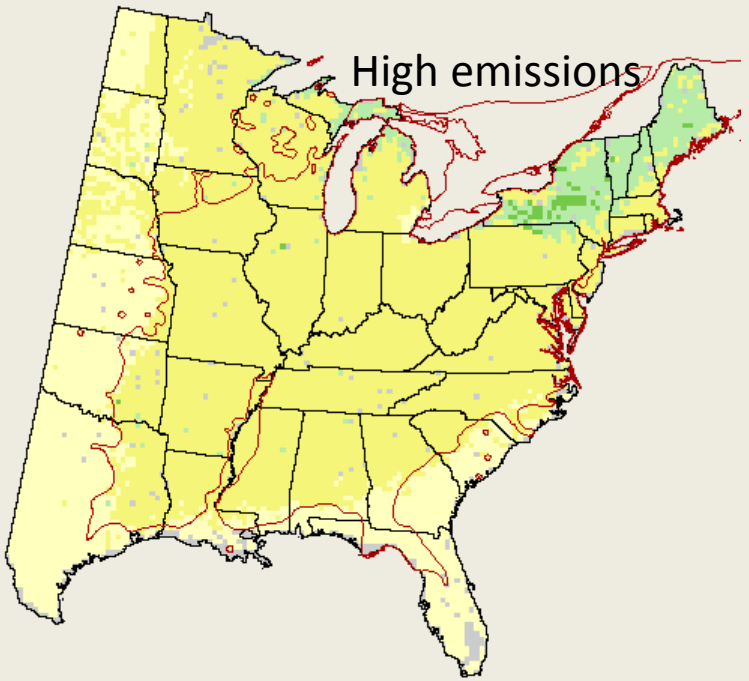
Low emissions



High emissions



Other Decreasers

white spruce

sweet birch

Atlantic white cedar

chestnut oak

red pine

eastern white pine

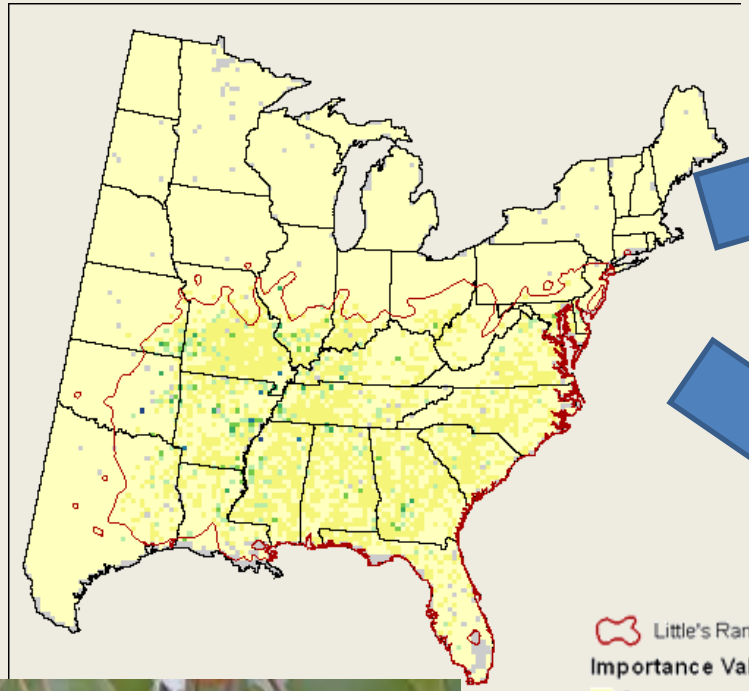
American basswood

northern white-cedar

bigtooth aspen

Virginia pine

Common Persimmon



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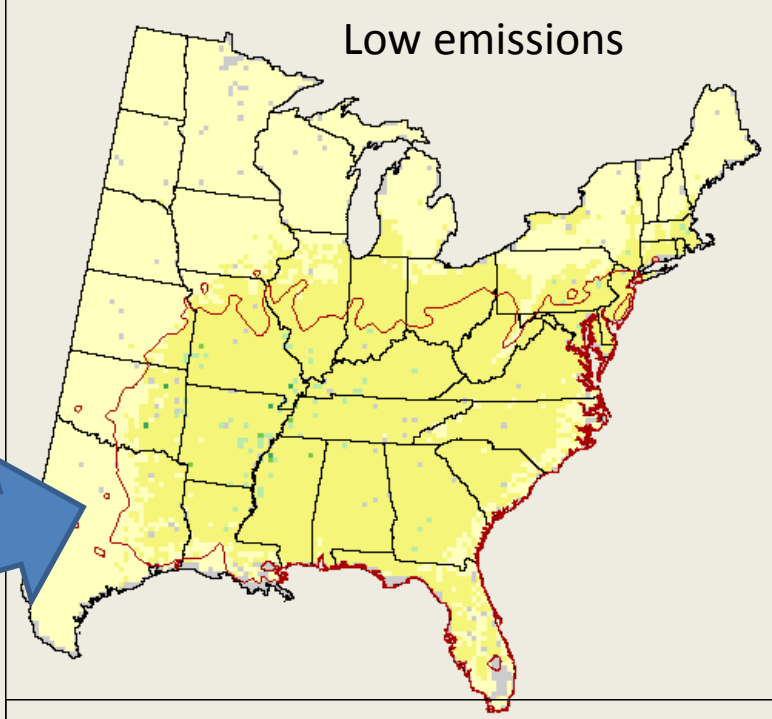
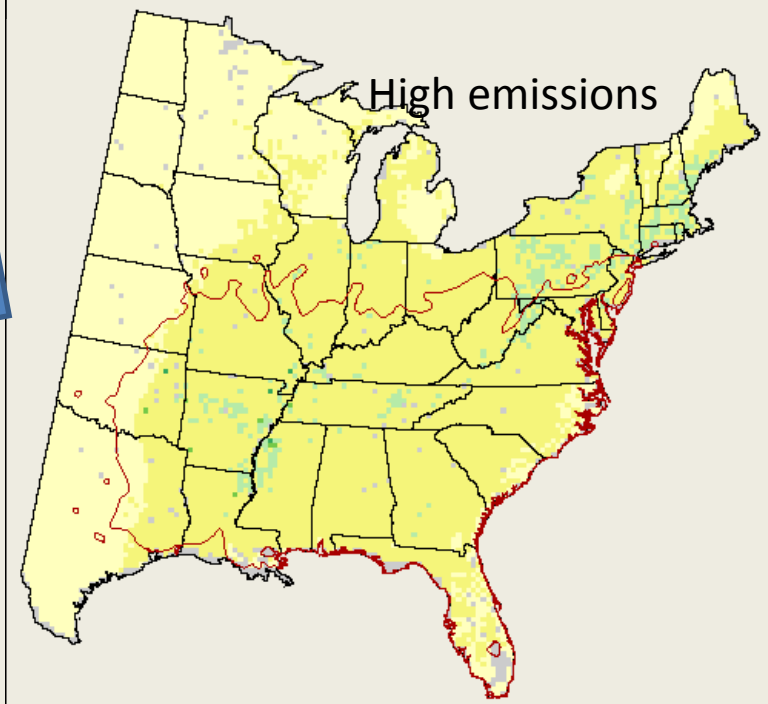


High emissions



Increase in southern oaks, hickory, pines

southern red oak

blackjack oak

pin oak

post oak

bitternut hickory

shagbark hickory

shortleaf pine

loblolly pine

Other increasers

pawpaw

black willow

American elm

Sweetgum

Eastern redbud

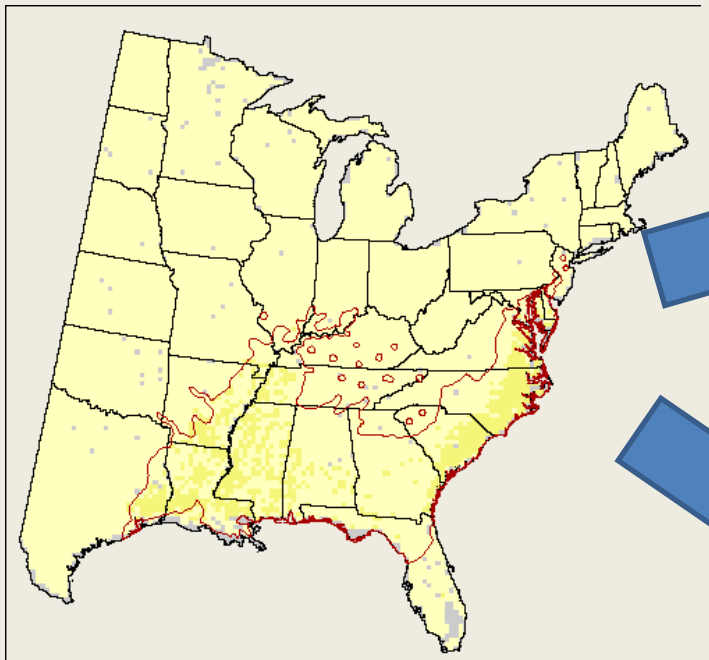
Persimmon

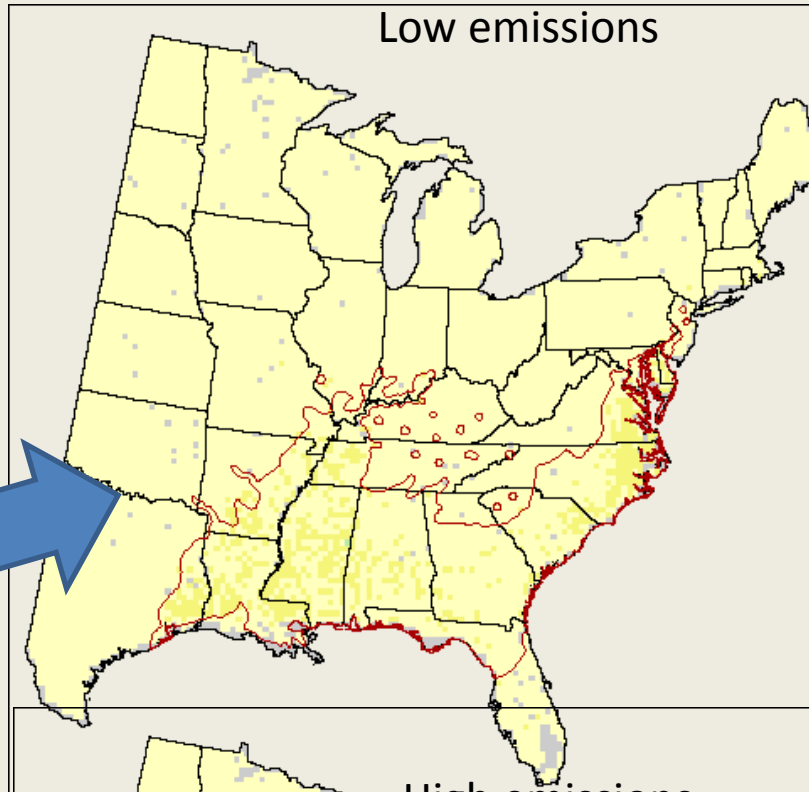
hackberry

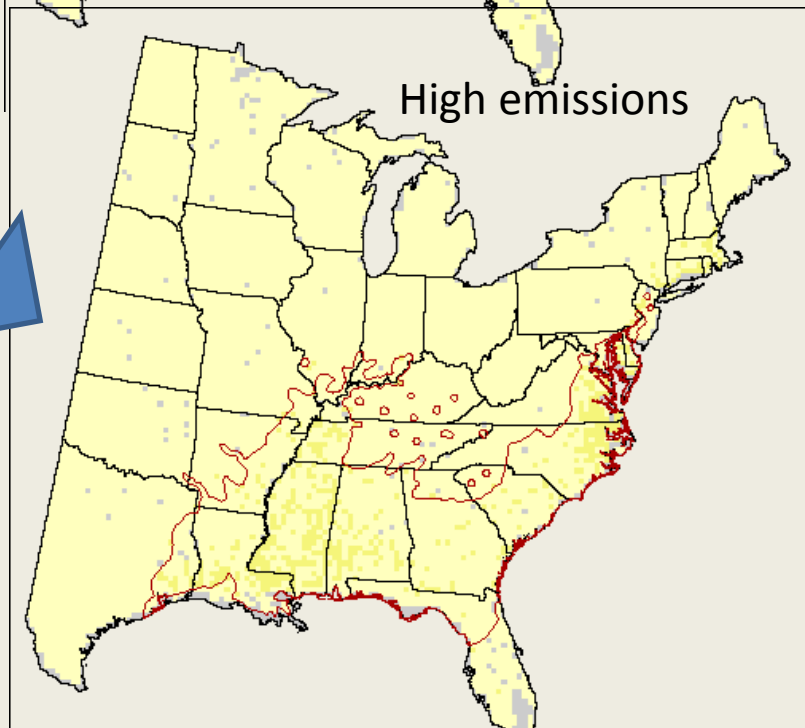
honeylocust

American holly

Swamp chestnut oak







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New Habitat

Ohio buckeye

pecan

shellbark hickory

black hickory

sugarberry

sourwood

winged elm

cedar elm

More Species with New Habitat

pond pine

turkey oak

swamp chestnut oak

chinkapin oak

shingle oak

water oak

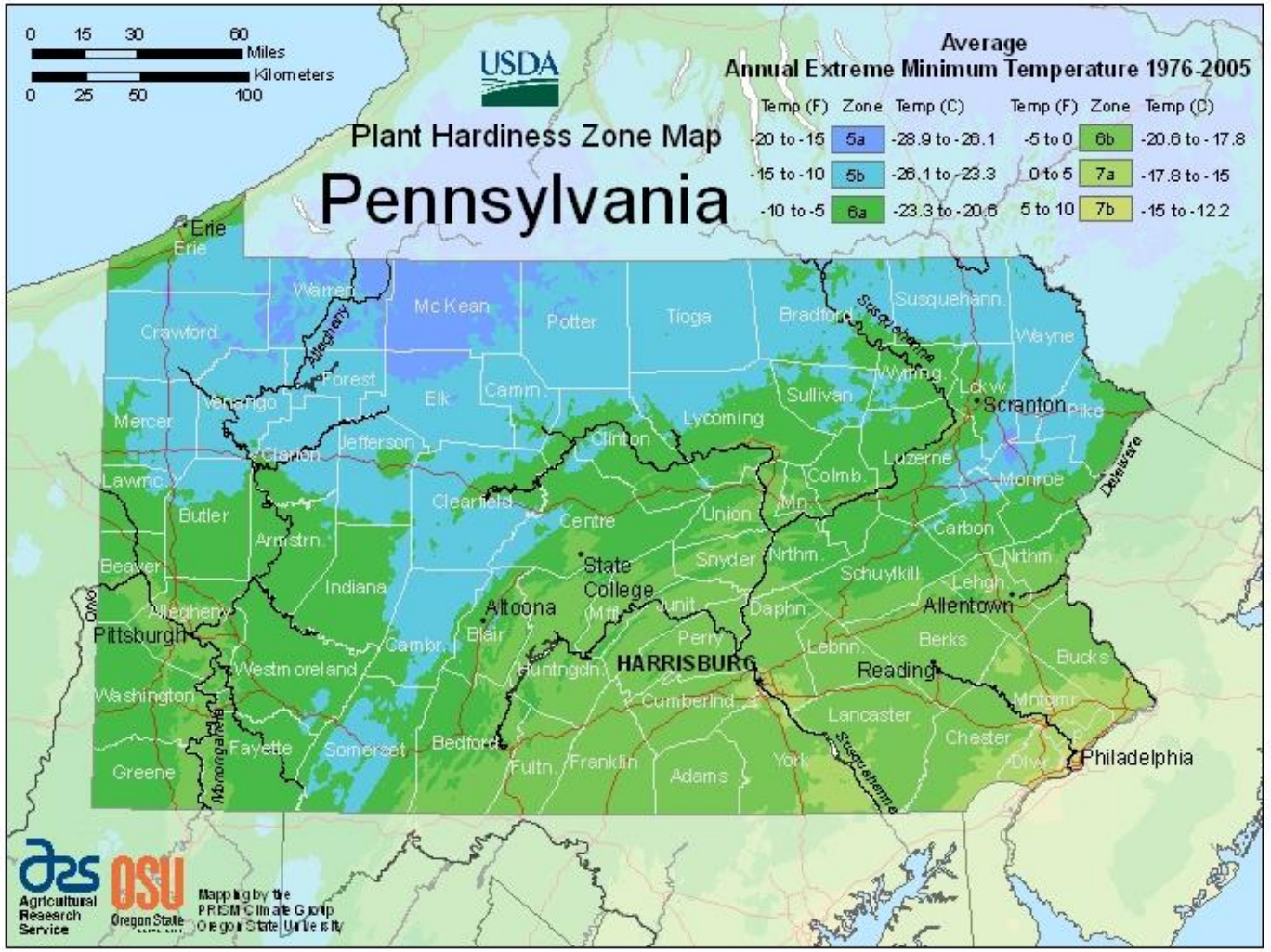
cherrybark oak

Shumard oak

Baldcypress

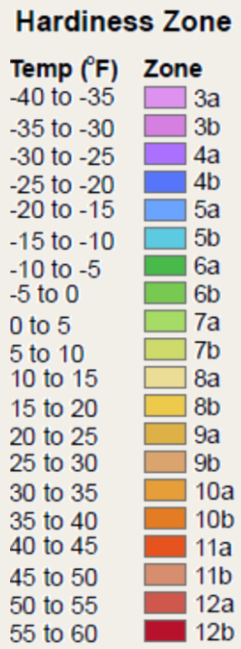
Non-Natives, Invasives, Cultivars?

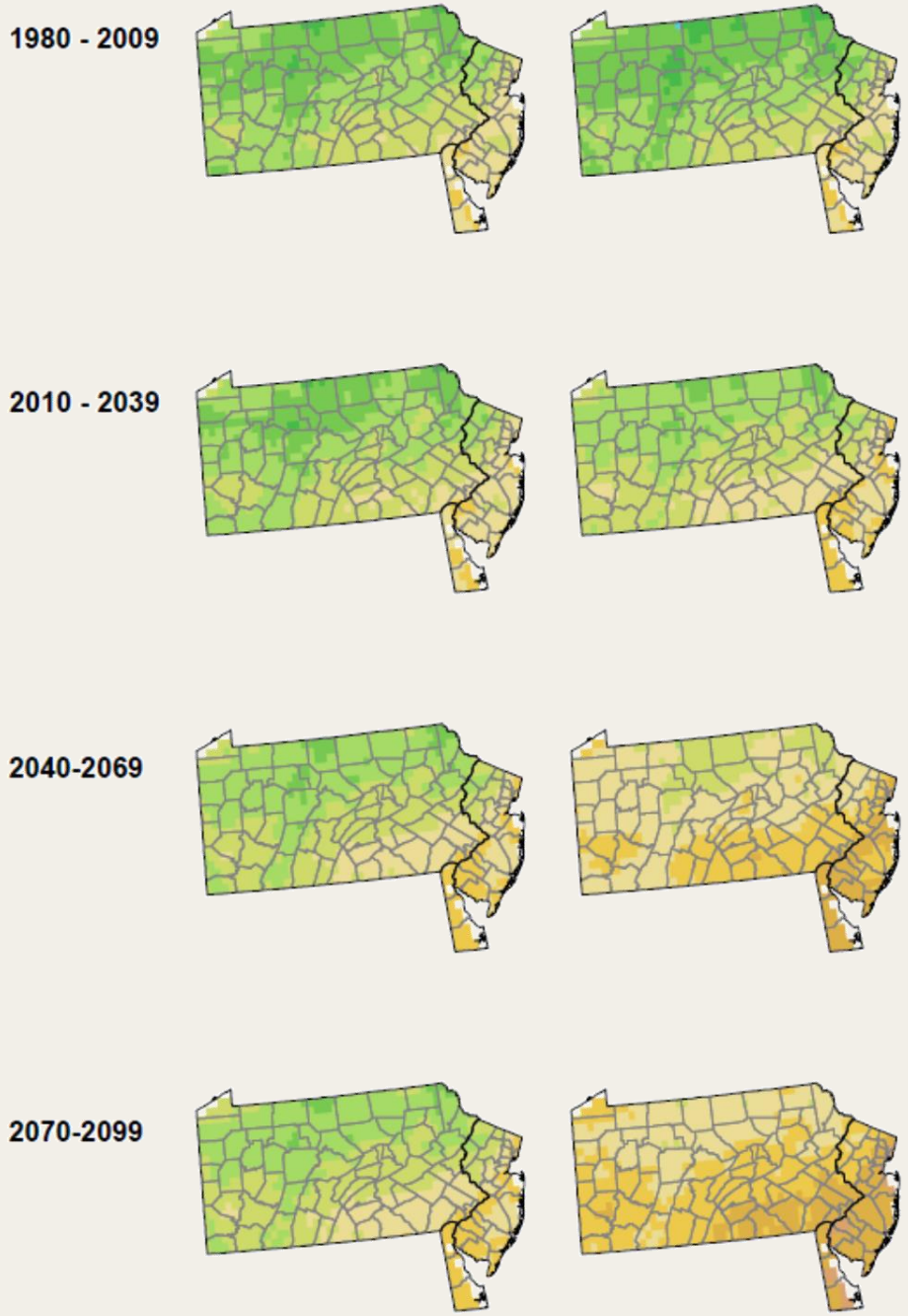
Current USDA Hardiness Zones



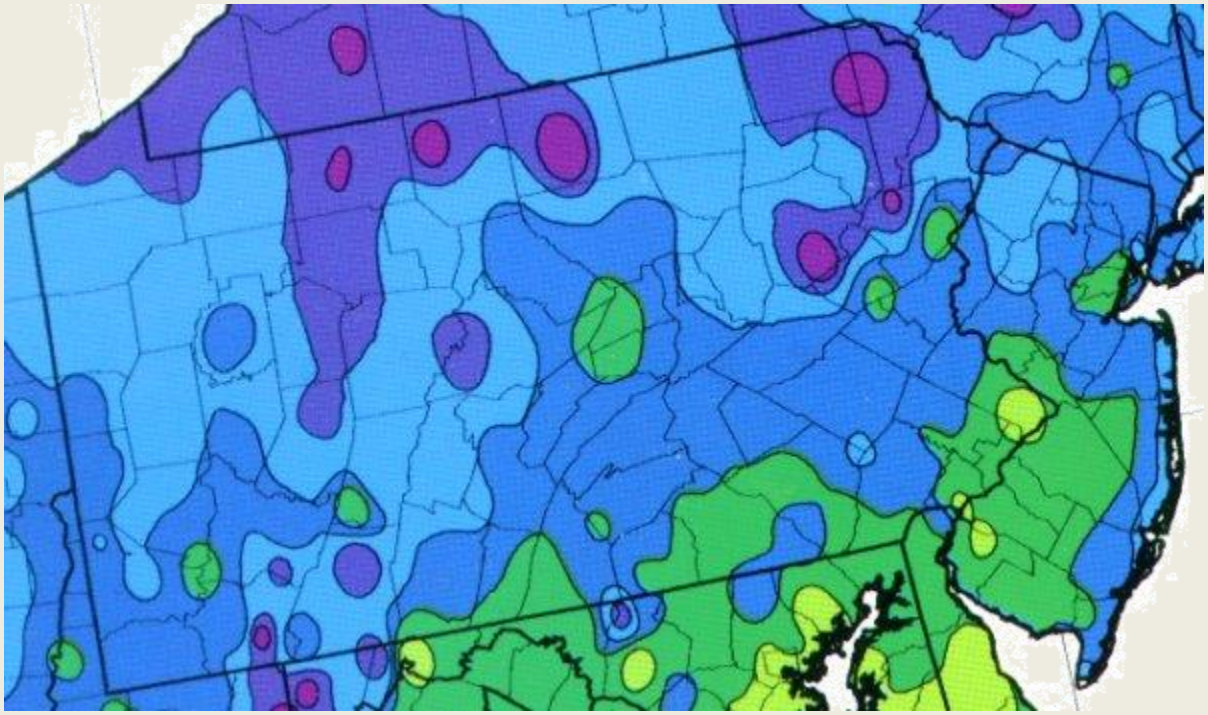
Changes in Hardiness Zones

- Based on average minimum temperature
- Shift of a half to one and a half hardiness zones





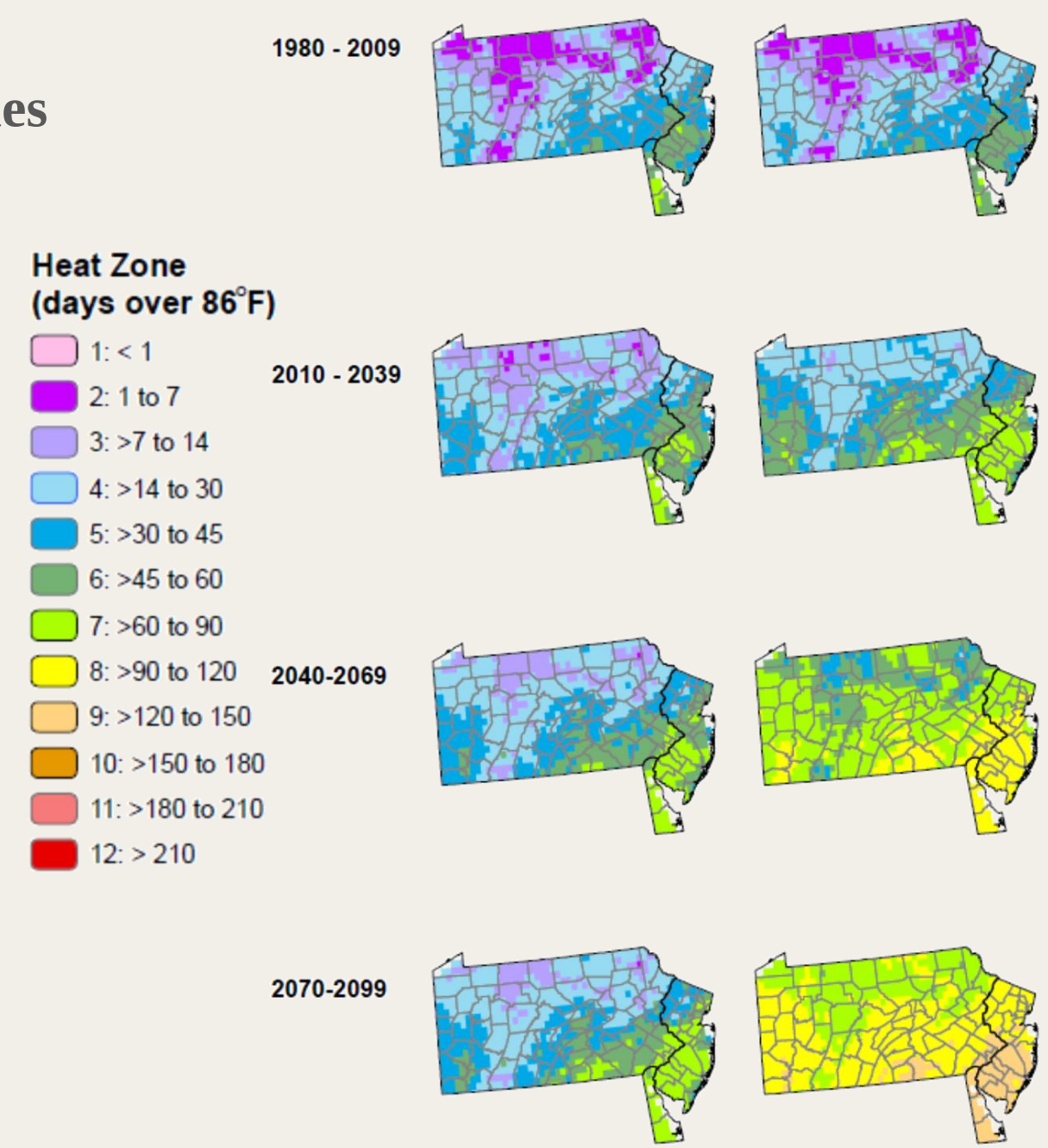
Current AHS Heat Zones



Average Number of Days per Year Above 86°F (30°C)	Heat Zone
< 1	1
1 to 7	2
> 7 to 14	3
> 14 to 30	4
> 30 to 45	5
> 45 to 60	6
> 60 to 90	7
> 90 to 120	8
> 120 to 150	9
> 150 to 180	10
> 180 to 210	11
> 210	12

Changes in Heat Zones

- Based on number of hot days
- Shift of 1-3 heat zones
- 1-2 months more hot days!



Douglas Fir

Hardiness zone range: 4-7

Heat zone range: 1-7

May experience heat stress

Momi Fir

Hardiness zone range: 6-9

Heat zone range: 1-10

Heat and hardiness zones within projected ranges

Selecting trees based on heat and hardiness zone

- Hardy to zone 6, but may be able to experiment with trees that are hardy to zone 7 in some areas
- Have a hardiness zone upper limit of 8 or higher (or 9 or 10 for harsher sites and longer-lived species)
- Have a heat zone tolerance of 8 or (for long-lived species or urban sites, 9) higher

Adaptive Capacity

Ability of a species or system to cope with change with minimal disruption.

Species with High Adaptive Capacity

- Pests, disease resistant
- Drought-tolerant
- Flood-tolerant
- Wind, ice-resistant
- Wide temperature tolerance
- Tolerates urban conditions (salt, pollution, restricted rooting conditions)
- Shade-tolerant
- Can be planted on a range of sites, soils
- Easily propagated and established once planted

High Adaptive Capacity: Kentucky Coffeetree

- No major pest/disease issues
- Adaptable to a range of soils, climates
- Urban-tolerant
- Low maintenance
- Widely available

Low Adaptive Capacity: Tulip-Tree

- Highly susceptible to ice damage, weak wood
- Intolerant of salt
- Intolerant of drought
- Intolerant of flooding

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Other forest impacts

Invasive species

- More carbon dioxide may favor weedy species
- Invaders can easily disperse to new areas
- Some may take advantage of longer growing seasons
- Tend to be disturbance-adapted

Kudzu

Kudzu is reproducing in Pennsylvania (photo from Lebanon County)

Hemlock Wooly Adelgid

Oak wilt

Native Pests: Southern Pine Beetle

Longer growing seasons

Opportunities:

- More growth
- More carbon storage

Risks:

- “false springs”
- Invasive species
- Insect pests

Salinity- “Ghost Forests”

Ted Blanco/Climate Central

Key Impacts

- Warmer, especially in winter
- Longer growing season, heat and hardiness zone shifts
- Wetter, especially in winter and spring
- Sea level rise and greater salinity
- Species range shifts
- More stress from invasive species, pests, and diseases

Impacts activity

- Think of a place you own or manage
- Review the list of impacts, and think how location may differ from the region as a whole (slope, aspect, soils, hydrology, development)
- Record local considerations in the right column
- When finished, select the six impacts you think are going to have the biggest impact on your area.

Questions

- Why did you select the impacts you did?
- Were these things you would be concerned about anyway regardless of climate change?

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Adaptation Options

Adaptation Options

Reduce impacts/
Maintain current conditions

Forward-looking/
Promote change

Resistance Strategies

- Water during hot, dry periods
- Using systemic insecticides for Ash trees
- Protect/maintain cold-adapted trees on the north side of buildings/north facing slopes
- Install dry wells to control flooding

Village of Hazel Crest, IL

Resistance Pros/Cons

Pros

Usually in-line with current policies and management goals

Not usually controversial

May be best hope for at-risk species and ecological communities

Cons

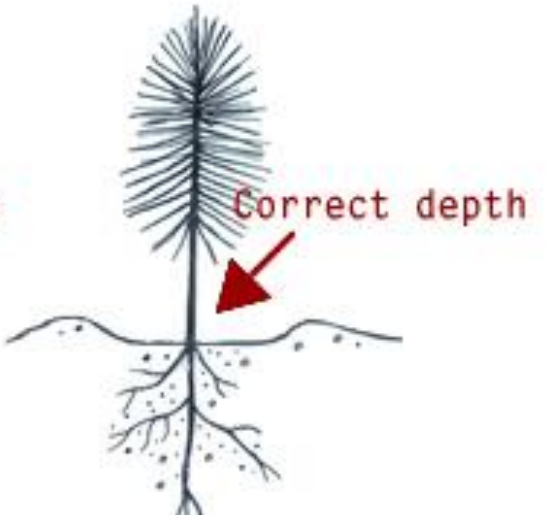
Costly

May not be effective in the long run

Time-intensive

Resilience Strategies

- Plant native species that are not common in your neighborhood/location to enhance diversity
- Plant trees and other native plants that can withstand a variety of stressors (drought, flooding, wind) and are adapted to your soils
- Prune to reduce susceptibility to storm damage
- Plant trees at the proper depth for greater stability and health



Urban Forestry Basic Training- Chicago

Resilience Pros/Cons

Pros

Usually in-line with current policies and management goals

Not usually controversial

May help reduce risks to other disturbances beyond climate change

Cons

Management may not be sufficient to deal with unprecedented disturbances

Management decisions are often made with historic range of variability in mind instead of future change

Transition Strategies

- Incorporate rain gardens
- Incorporate future-adapted species, seed sources
- Consider transitioning to new plant community assemblages

Riverside:
Buckeye, accolade elm, pecan

Transition Pros/Cons

Pros

Ecosystems most likely to align with and withstand current and future conditions

May be less costly in the long run

Cons

Up-front costs may be higher

May be policy or social barriers to implementation

Uncertainty in climate projections

Risks associated with introducing new species/genotypes

Adaptation Options

Reduce impacts/
Maintain current conditions

Forward-looking/
Promote change

Adaptation Activity

- Write your top impacts (from last activity) in the first column.
- For each impact, record how you think it may affect your ability to care for trees, plants, or ecosystems at your location.
- In the last column, list potential strategies you could take to overcome challenges or capitalize on new opportunities (use adaptation strategies and approaches list).

Questions

- What is one example of a strategy you selected? What impacts does it address?
- Did your strategies tend to focus on resistance, resilience, transition, or a combination?

Steps to Getting Your Trees Climate-Ready

1. Know your local impacts
2. Understand how trees may respond differently
3. Assess your options to adapt
4. Take action

Next Steps

- Learn more about local climate change impacts
- Read *Forest Adaptation Resources*
- Develop an adaptation plan using the adaptation workbook (Online: adaptationworkbook.org)
- Stay in touch! lbrandt@fs.fed.us