Introduction to PINEMAP's Decision Support System (DSS)

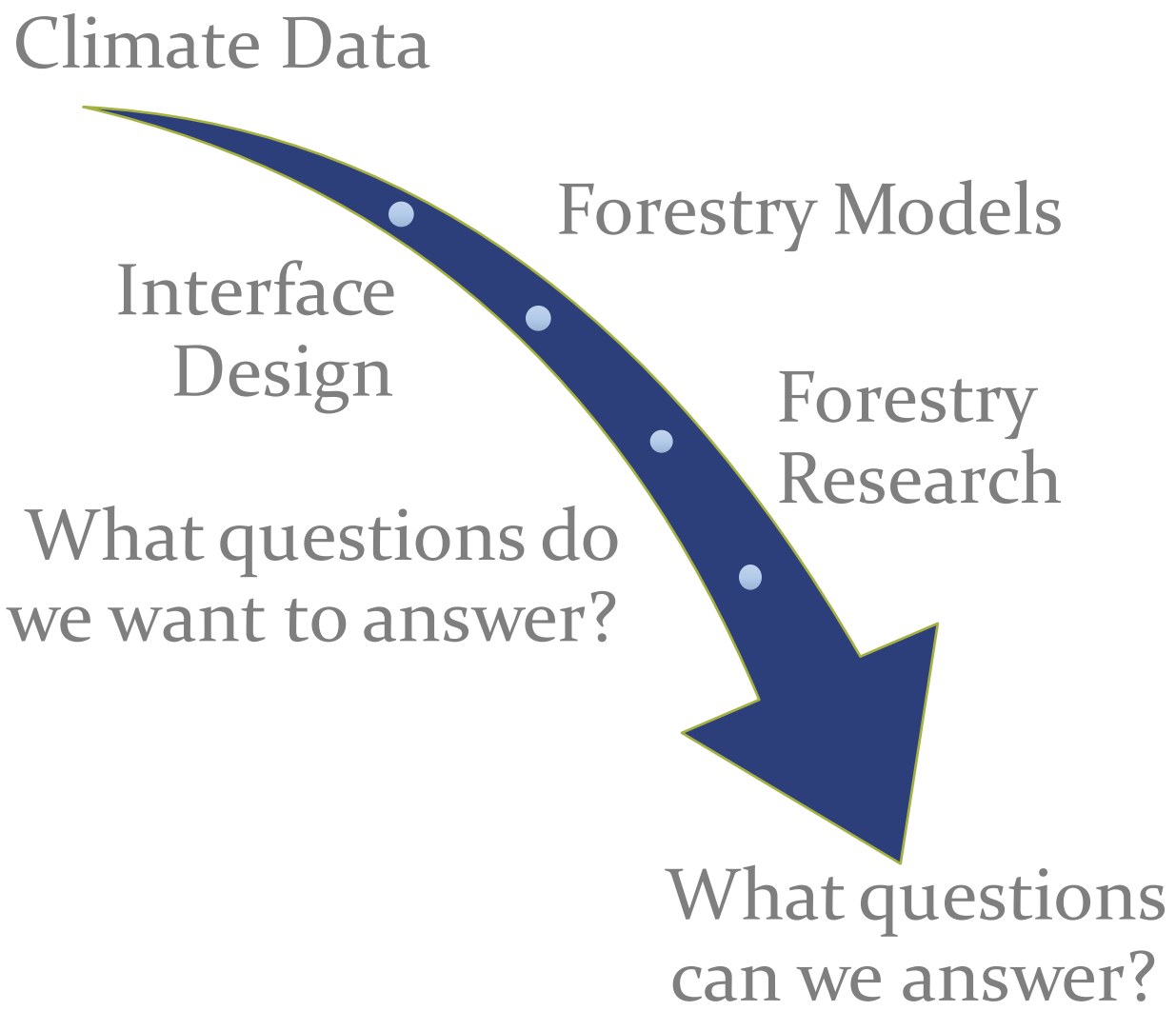
Heather Aldridge, Corey Davis, and the rest of the PINEMAP team

Pine Plantation Research and Decision Support Tool Rollout

May 16-17, 2017 Athens, GA

USDA United States Department of Agriculture National Institute of Food and Agriculture

How Did We Build the PINEMAP DSS?

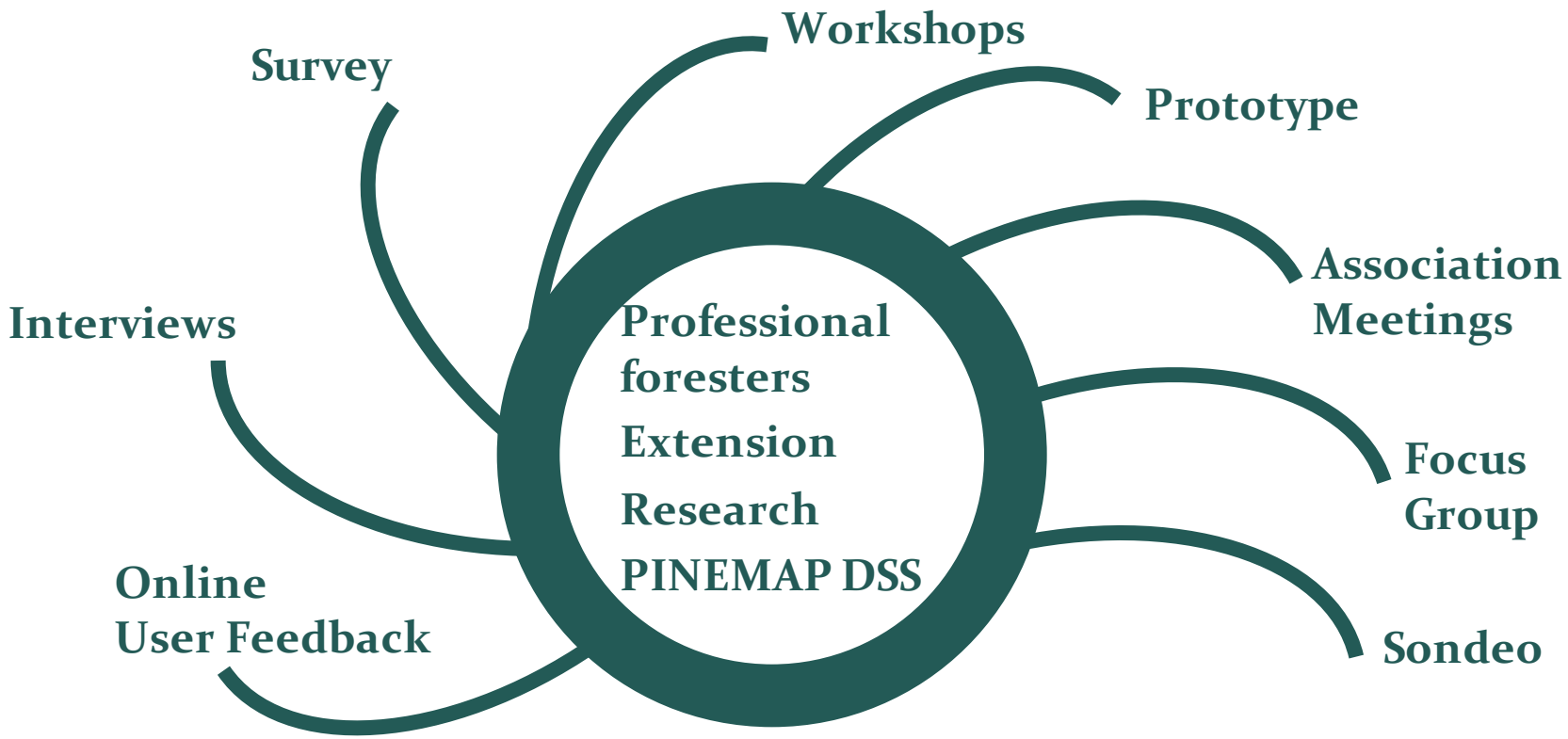


The DSS combines future climate projections for the next 100 years (in 20 year slices) with the latest forestry research.

How Did We Build the PINEMAP DSS?

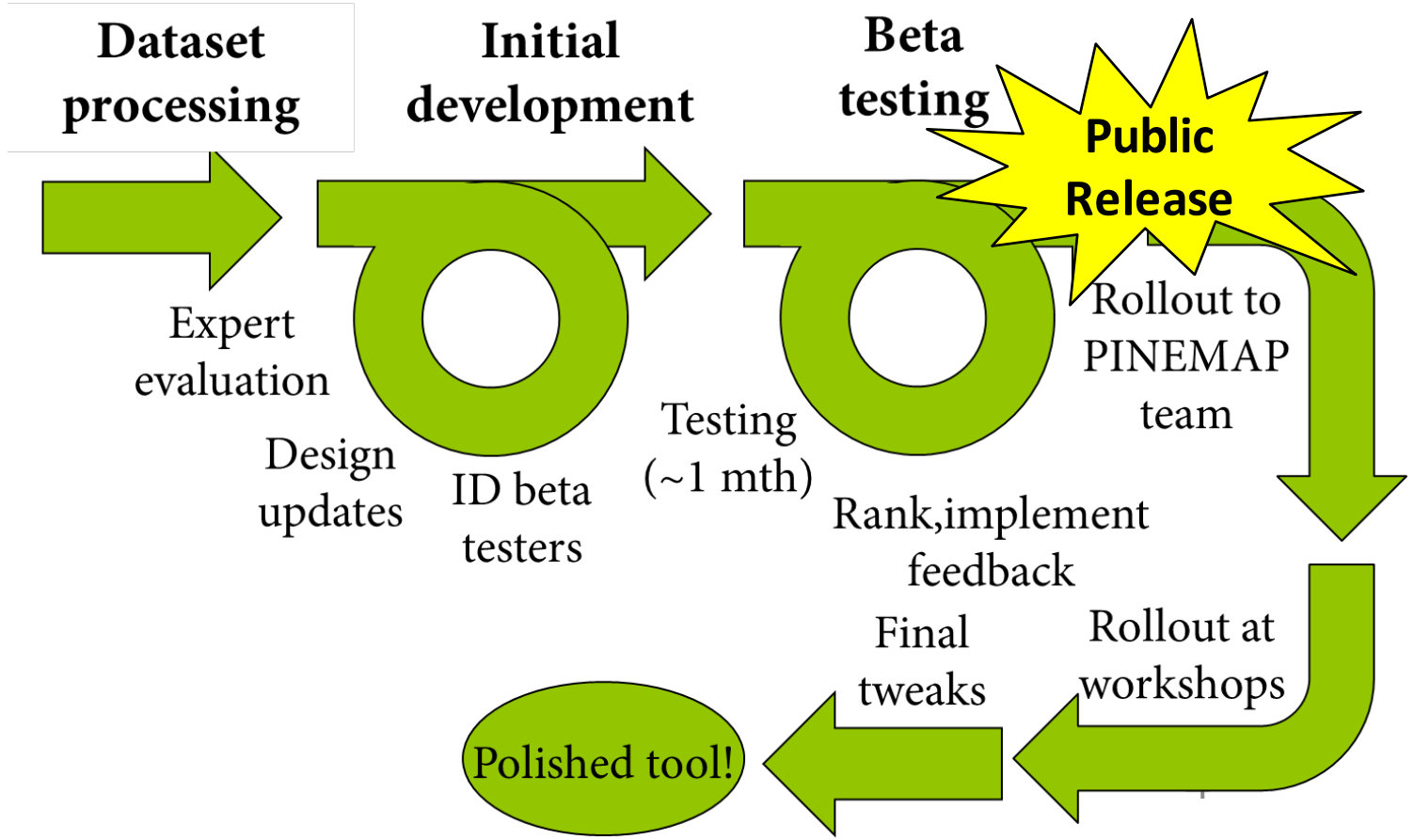
Iterative process of development

Southeast Climate Consortium multi-feedback loop model:



Overview: Tool Development (Iterative)

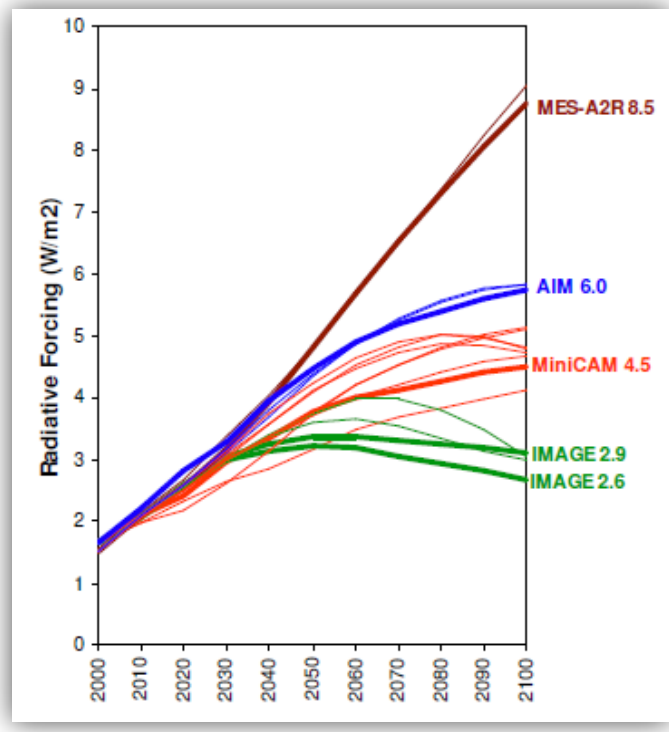
- **Goal**: To provide users with ***access*** to future climate projections, ***visualizing*** the ***data*** in a ***meaningful*** way
- Beta testing and refinements (~2 month process each round)



Climate Model Projections

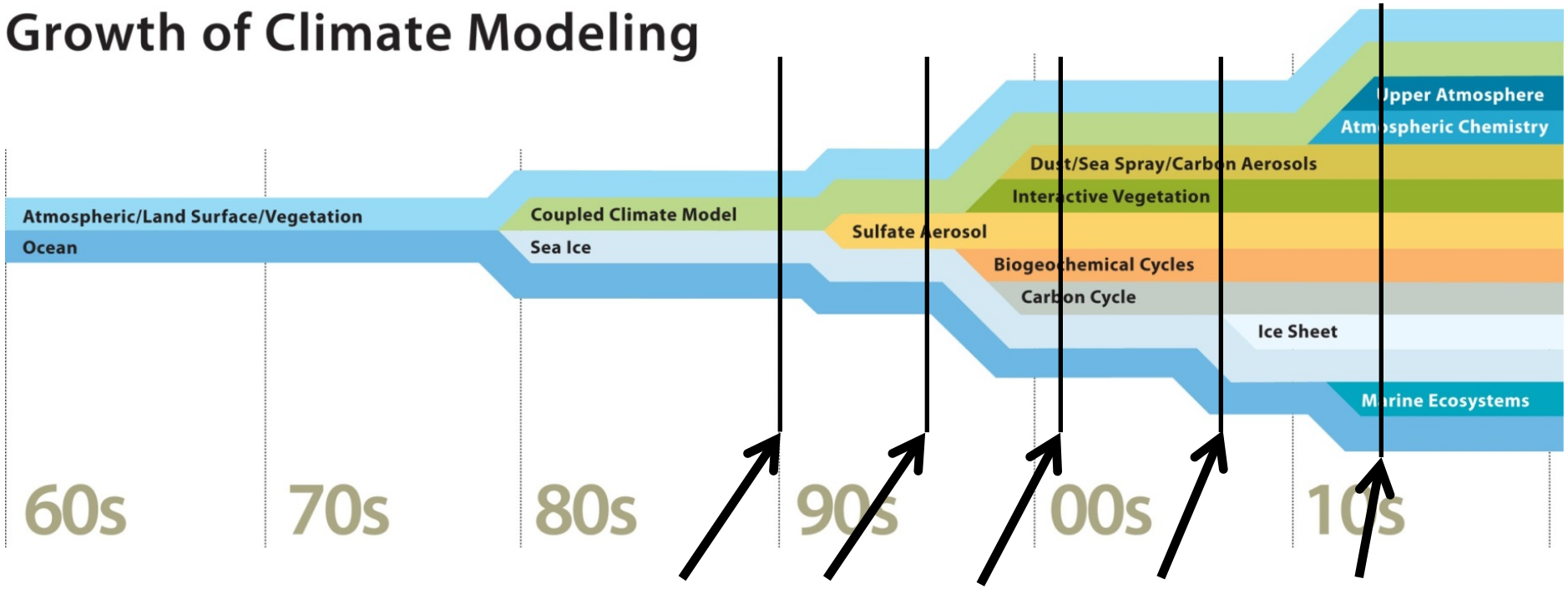
- Global Climate Models (GCMs) are ***not*** trying to predict the weather on any given day.
- Instead – we want to understand how weather ***on average*** will change given some changes in external forcing.
  - What happens if CO_2 doubles?

Climate Models are projections and dependent on the assumptions made about external forcing, such as changes in CO_2.



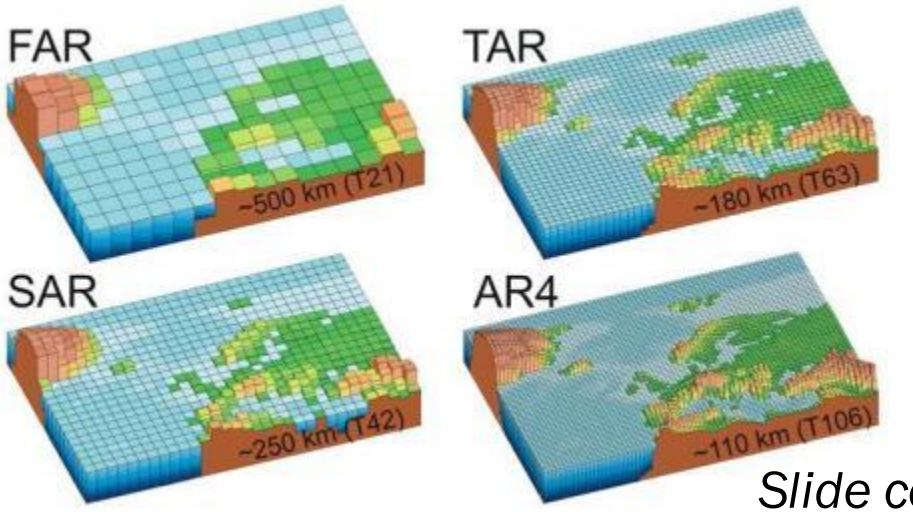
Slide courtesy of Dr. Adrienne Wootten, South Central CSC

Growth of Climate Modeling



Weather Models Incorporate only Atmosphere and Ocean

FAR 1990 | SAR 1995 | TAR 2001 | AR 4 2007 | AR 5 2014



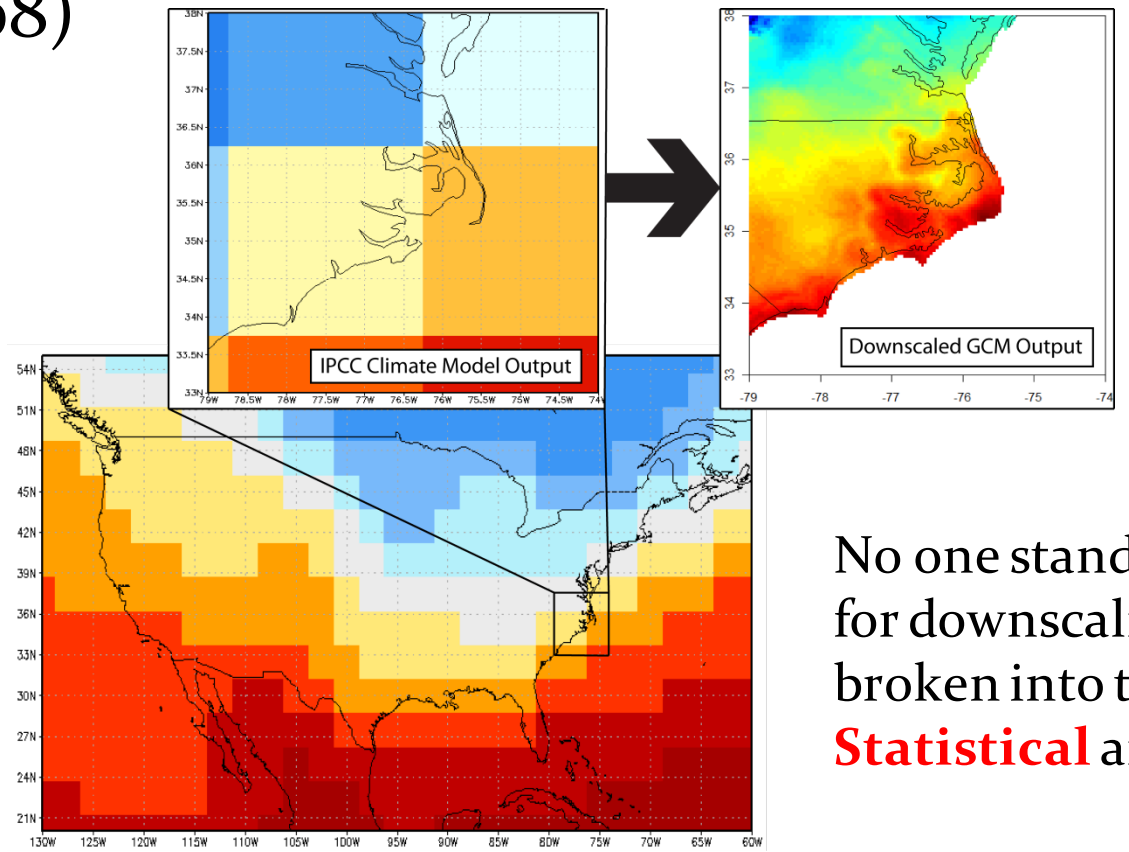
Increasing number of physical processes are gaining representation, resolution is getting finer. But resolution is still not fine enough for local applications.

Slide courtesy of Dr. Adrienne Wootten, South Central CSC

Downscaling

"the process of making the link between the state some variable representing the large space and the state of some variable representing a much smaller space."

Benestad (2008)



No one standard technique for downscaling. Generally broken into two categories: **Statistical** and **Dynamic**

Slide courtesy of Dr. Adrienne Wootten, South Central CSC

Local Projections

- Global Climate Models can't provide meaningful guidance locally
  - Downscaling allows the exploration of local potential impacts.
- Multiple agencies, academia and others have many sets of local projections using downscaling
  - Google Search (30+), In House by different agencies (hundreds)

Slide courtesy of Dr. Adrienne Wootten, South Central CSC

Emissions Scenarios

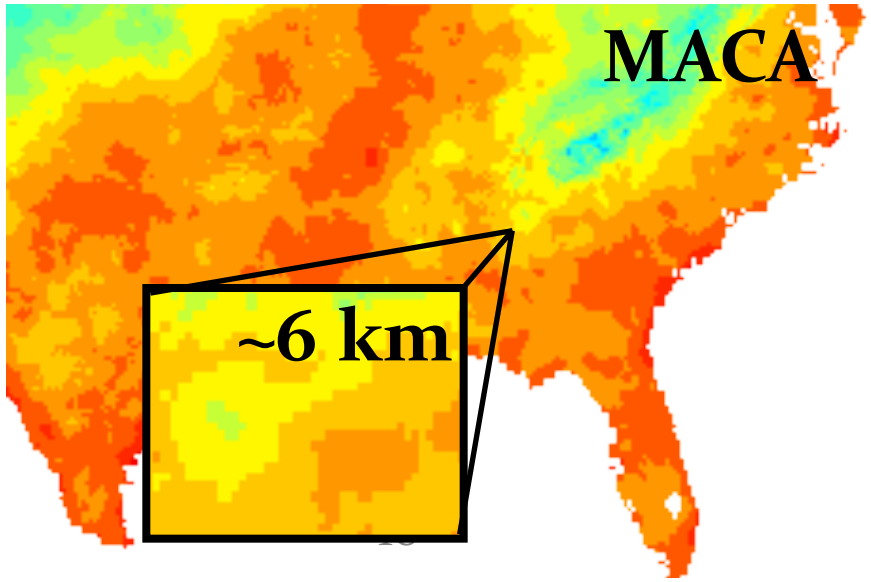
- Used to define changes with human action (i.e. more or less emissions from human activities in the future)
- High emissions – no restraints on emissions in the future
- Low emissions – restraints on emissions in the future

Slide courtesy of Dr. Adrienne Wootten, South Central CSC

PINEMAP's Climate Projection Dataset

Multivariate **A**daptive
Constructed **A**nalogs

MACA



- University of Idaho's downscaled climate data
- Statistical downscaling method – daily data
- 20 different General Circulation Models
- 6km resolution
- Used by IPCC 5th Assessment

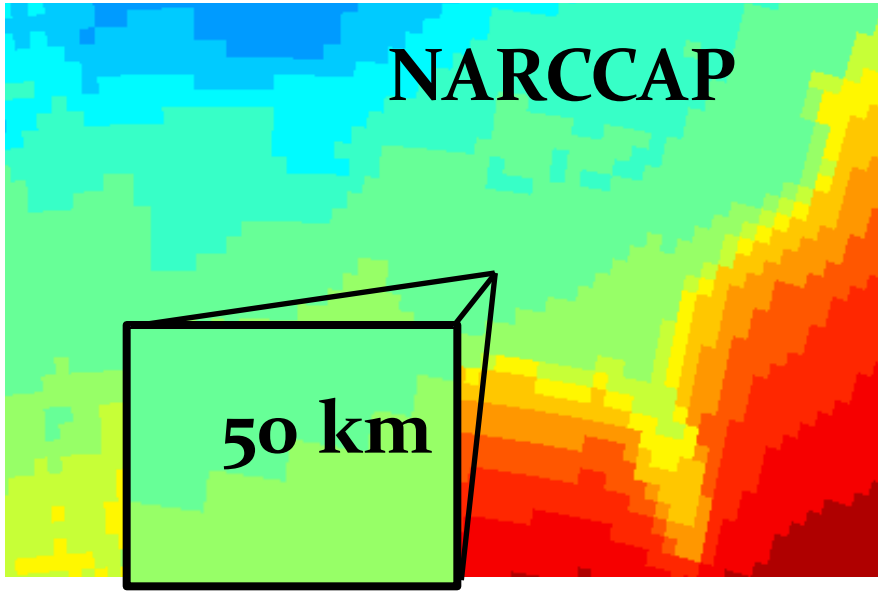
What Variables Can We Project?

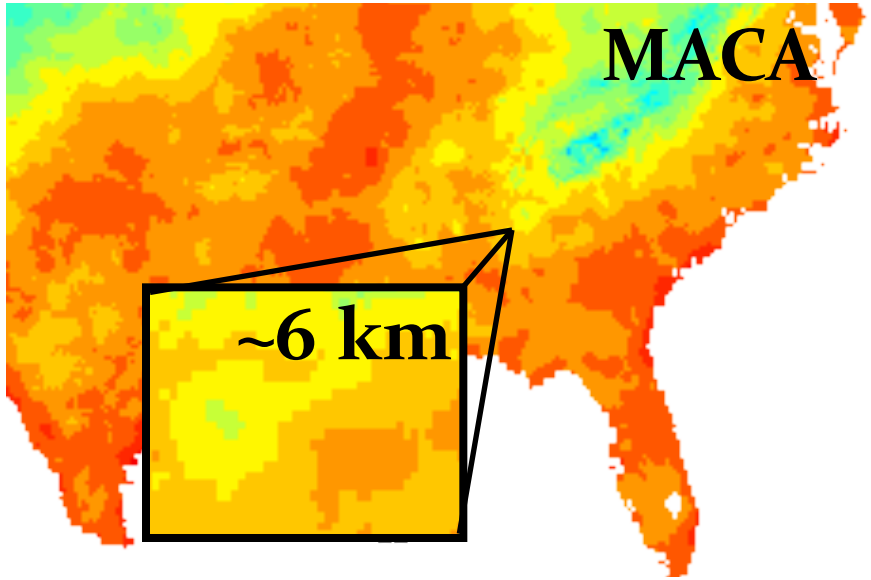
- mean wind speed
- mean specific humidity
- shortwave radiation

(heat reaching soil surface)

- min air temperature
- max air temperature
- accumulated precipitation

Example -- spatial resolution differences:





Modeled Scenarios in the MACA dataset

Baseline

- 1950-2005
- Model has its own physics
- Simulated over this period compared to actual data- validates model!

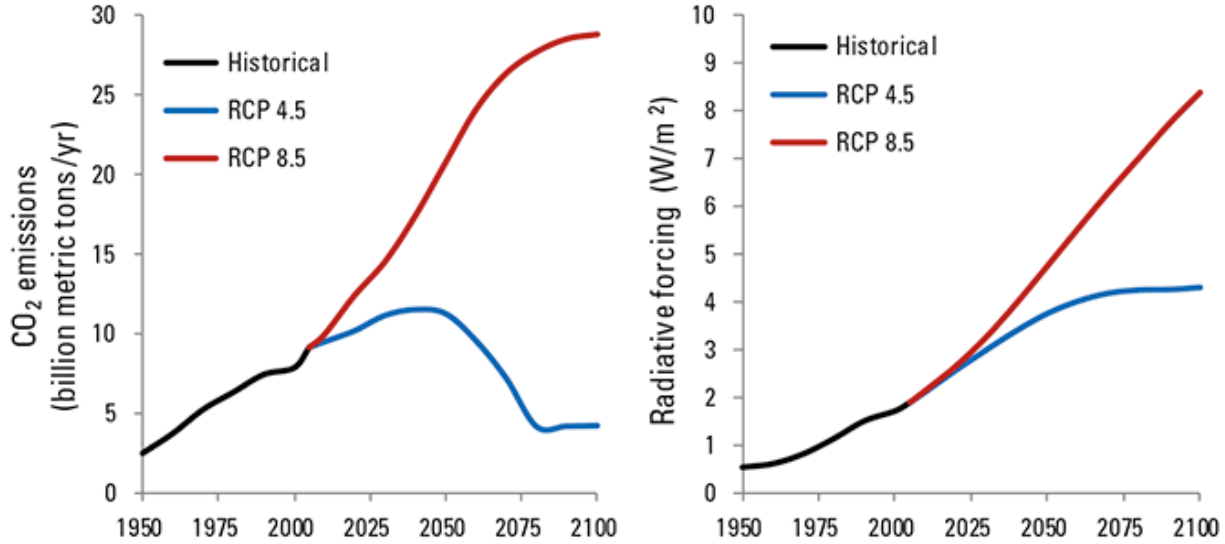
1. Moderate level of Emissions (CO_2 Concentration)

- Reduced levels of emissions/CO2 concentration
- Representative Concentration Pathway (RCP) 4.5 Watts/m²
- 2006-2099

2. High Level of Emissions (CO_2 Concentration)

- Based on current trajectory
- Representative Concentration Pathway (RCP) 8.5 Watts/m²
- 2006-2099

Representative Concentration Pathways



Representative Concentration Pathways (RCPs), or scenarios that represent potential changes in ***greenhouse gas emissions (e.g., CO_2)*** and ***radiative forcing*** (the difference between the incoming and outgoing energy in the atmosphere from both manmade and natural sources).

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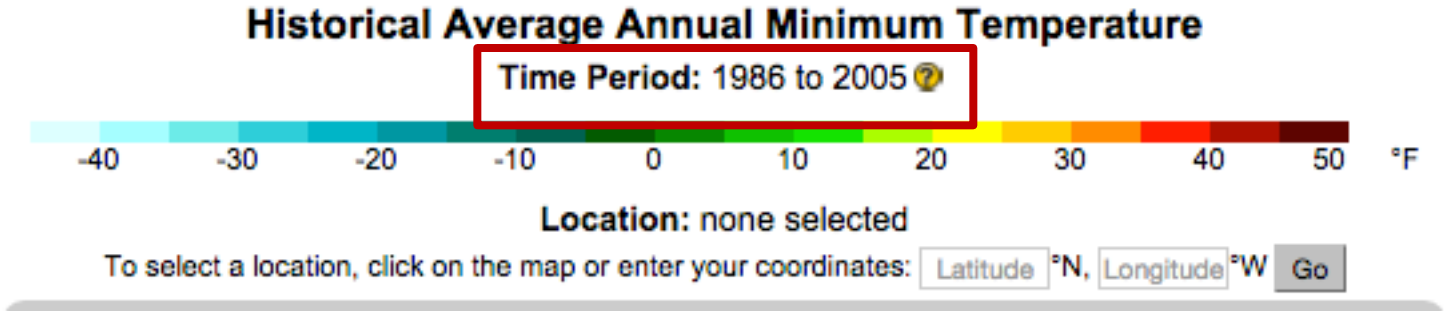
PINEMAP Regional Modeling

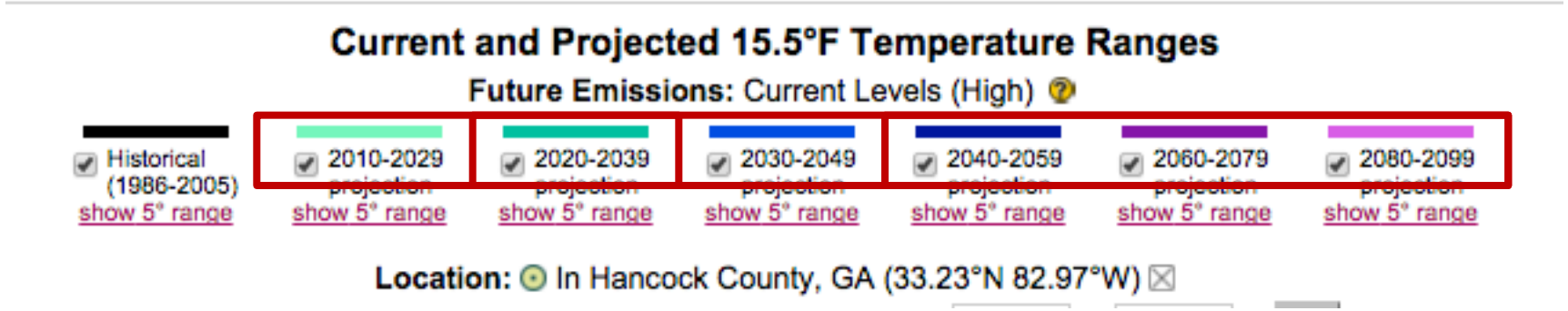
Suite of complementary models focused on understanding opportunities and risks, and comparing management alternatives under future predicted climate

Growth and yield (climate-responsive)
Water Supply Stress Index (WaSSI)
Physiological Principles Predicting Growth (3-PG)
Community Land Model (CLM-BGC)
Sub-regional Timber Supply Model (SRTS)

Climate Data Projections out to 2099

- 20 year time slices: historical & future projections
- Two different emissions scenarios





Tools Structured into Four Groups

1. Environment

Temperature
- Minimum Temperature Thresholds
- Summer Temperature

Precipitation
- Summer Precipitation

Drought
- Summer Dryness Index

2. Establishment

Dynamic Hardiness Zones
- Cold-Tolerant Markets for Nurseries
- Source Ranges for Greater Productivity

3. Management

Strategies
- Water Yield
- Gross Ecosystem Productivity

Biomass
- Green Weight
- Stem Volume Outside Bark
- Basal Area

4. Production

Carbon Flux
- Gross Primary Productivity
- Net Primary Productivity

Stand Attributes
- Leaf Area Index
- Stem Dry Mass

Water
- Evapotranspiration

Climate-Related DSS Metrics / Tools:

Precipitation:

- Summer Precipitation

Temperature:

- Number of Days with Min Temp Below Certain Thresholds
  - <32°F, <28°F, <25°F, <20°F, and <15°F
- Summer Temperature

Drought:

- Summer Dryness Index
  - Ratio of summer growing degree days to summer precipitation

Dynamic Hardiness Zones:

- Cold-Tolerant Markets for Nurseries
- Source Ranges for Greater Productivity

Example Climate-Related DSS Metric / Tool: Number of Days with Min Temp Below 32°F

How was this calculated from MACA daily data?

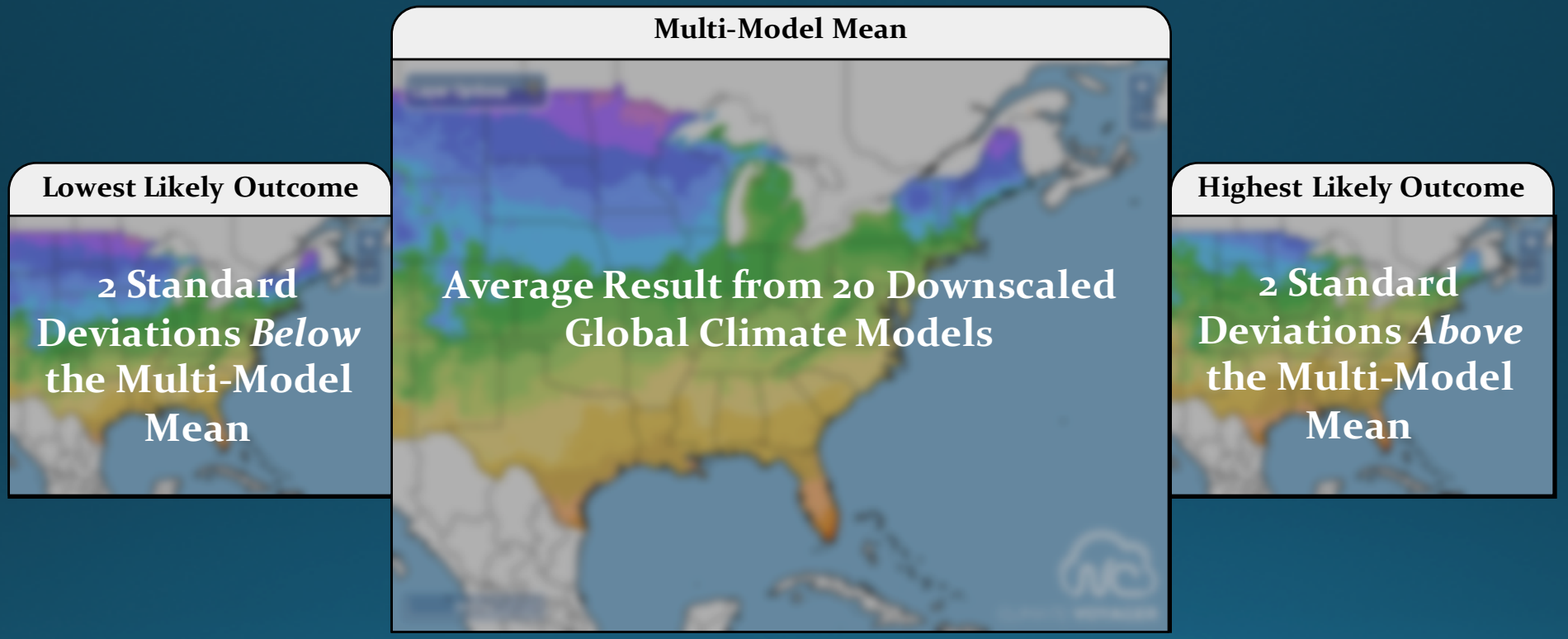
- For each day, determined if the minimum temperature was <32°F.
- Counted up the number of days <32°F per year (1 value per year per model per scenario – baseline or RCP).
- Averaged those values across the years 1986-2005 and the 4 future time periods.

DSS Features - Future Data Visualization

1. Three-Map Layout

2. Time Series Plot

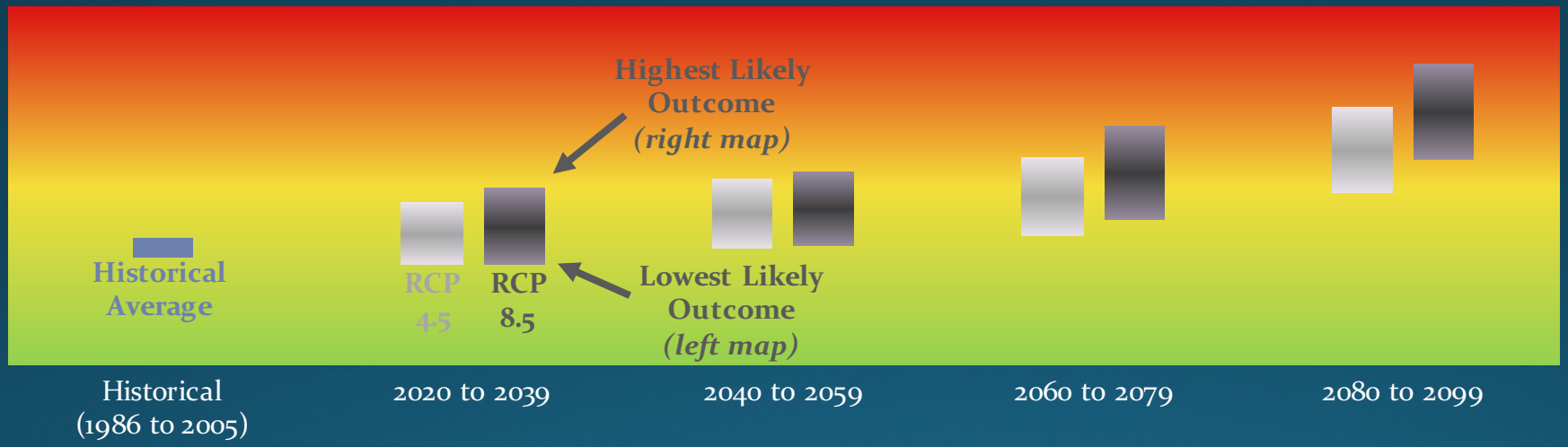
1. Three-Map Layout



Model Spread
(95% of all Guidance)

2. Time Series Plot

Summarizes model projections for all future time slices and emissions scenarios ***at a single location***.



Live Demo of DSS features / tools http://pinemapdss.com

PINEMAP DECISION SUPPORT SYSTEM

About | Environment | Establishment | Management | Production

DSS Introduction

The guide below describes the features of the PINEMAP Decision Support System. Once you're ready to begin using the DSS, select a tool using the menu above.

1. Background
2. About DSS Tools
3. Climate Data
4. Emissions Scenarios
5. Three-Map Layout
6. Time Series

- You can use tools in the PINEMAP DSS to explore **climate-based risks and opportunities** for loblolly pine growth
- Pine trees influence their local climate yet are also themselves **sensitive to climate factors** including temperature and precipitation
- The Pine Integrated Network: Education, Mitigation, and Adaptation Project (**PINEMAP**) studies planted loblolly pine forests in the Southeast US

Summary of Climate Projection Outputs

Variable	Future Change
Number of Days with Min Temp Below Certain Thresholds (e.g., 32F)	Fewer days below these thresholds since min temperatures projected to warm
Summer Temperature	Temperatures projected to warm
Summer Precipitation	Projections range from drier to wetter

http://pinemapdss.com

Questions??? Suggestions???

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919-513-0244

Extra Slides

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- Pine trees influence their local climate yet are also themselves **sensitive to climate factors** including temperature and precipitation
- The Pine Integrated Network: Education, Mitigation, and Adaptation Project (**PINEMAP**) studies planted loblolly pine forests in the Southeast US
- DSS tools work best with the current version of major browsers in full-screen mode

Related Resources:

- *What is PINEMAP?*
- *More background on the PINEMAP DSS*

Links to interactive FAQ pages (also found in the "About" menu above)

USDA United States Department of Agriculture National Institute of Food and Agriculture

The Pine Integrated Network: Education, Mitigation, and Adaptation project (PINEMAP) is a Coordinated Agricultural Project funded by the USDA National Institute of Food and Agriculture, Award #2011-68002-30185.

If you have any questions, suggestions, or bugs to report with the PINEMAP DSS, please email us at **pinemap@climate.ncsu.edu**.

DSS Frequently Asked Questions

This page serves as a reference for the PINEMAP DSS and its tools and data.

What does the Minimum Temperature Thresholds tool show?

This tool displays counts of the average number of days in each calendar year with temperatures below a given threshold (e.g., 32°F), which can be changed in the tool options menu near the top of the page. The annual counts are then averaged over 20-year time periods.

Related Question: What is being shown on the historical data display and what is the data source?
Related Question: What is the data source for the future climate projections?
Related Question: What is being shown on the Projected Change data display?
Related Question: What is being shown on the Projected Average data display?

While extremely cold wintertime temperatures can be rare in more southerly parts of the United States, they can cause significant damage to loblloly pine trees that are exposed for even a short time. Knowing areas where these cold temperatures are and will continue to be common may affect your choice of seedlings and planting locations.

What does the Summer Temperature tool show?

What does the Summer Precipitation tool show?

What does the Summer Dryness Index tool show?

What does the Cold-Tolerant Markets for Nurseries tool show?

What does the Source Ranges for Greater Productivity tool show?

Minimum Temperature Thresholds

About This Tool

Temperature Threshold: 32°F

Map Display: Historical Observed | Projected Change | Projected Average (Historical Observed + Projected Change)

Future Time Period: 2040 to 2059

Future Emissions: Current Levels (High)

Projected Change in the Average Number of Days Per Year with Minimum Temperatures < 32°F

Time Period: 2040 to 2059 (compared with 1950 to 2005) **Future Emissions:** Current Levels (High)

+8 ±0 -8 -16 -24 -32 -40 -48 -56 -64 -72 -80 -88 -96 days

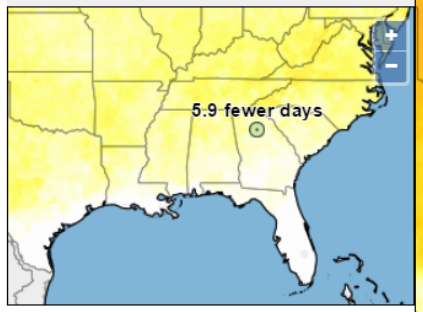
Location: In Gwinnett County, GA (33.96°N 83.87°W)

To select a location, click on the map or enter your coordinates: 33.96 °N, 83.87 °W Go

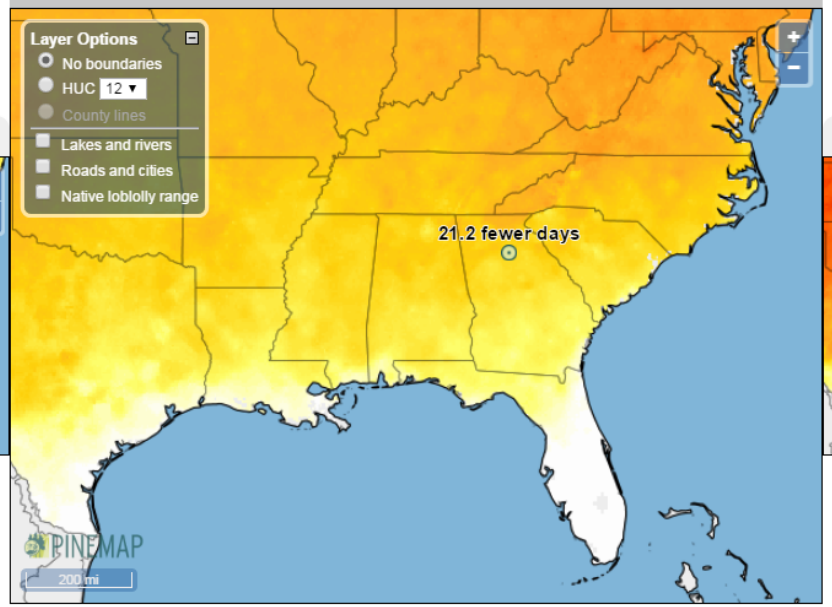
Map Help

About the Side Maps

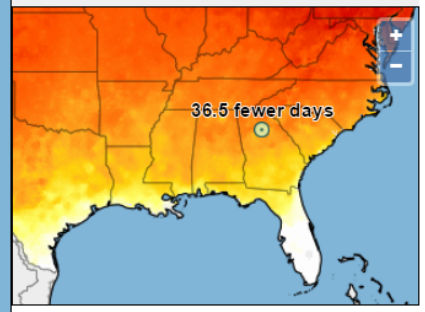
Lowest Likely Change



Multi-Model Mean



Highest Likely Change



Change in Average Number of Days Per Year with Minimum Temperatures < 32°F

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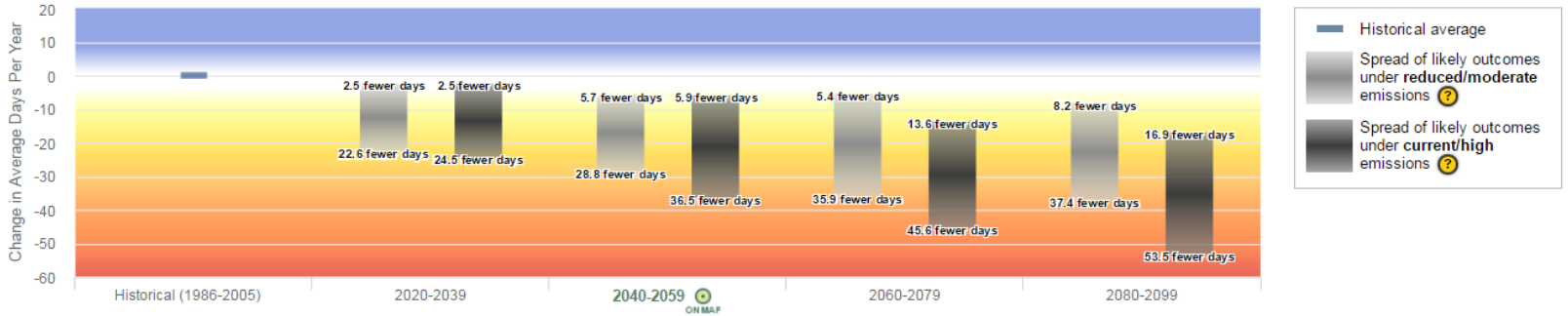
About The Time Series



Summer Precipitation

? About This Tool

Map Display ○ Historical Observed ◉ Projected Change ○ Projected Average (Historical Observed + Projected Change)

Future Time Period 2040 to 2059 ▾

Future Emissions Current Levels (High) ▾ ?

Projected Change in Average Summer (June - August) Precipitation

Time Period: 2040 to 2059 (compared with 1950 to 2005) **Future Emissions:** Current Levels (High)

-4 -3 -2 -1 ±0 +1 +2 +3 +4 inches

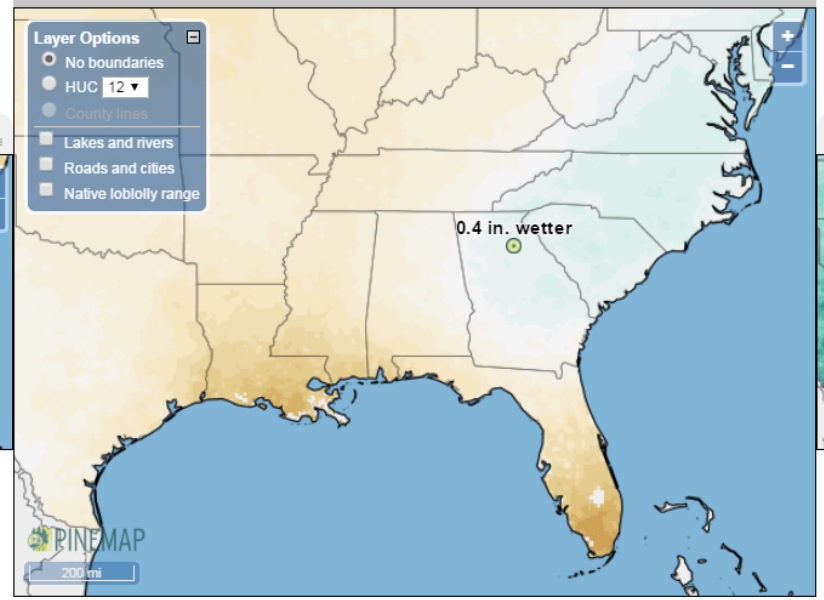
Location: ⊙ In Barrow County, GA (34.04°N 83.65°W) ☒

To select a location, click on the map or enter your coordinates: 34.04 °N, 83.65 °W Go

? Map Help

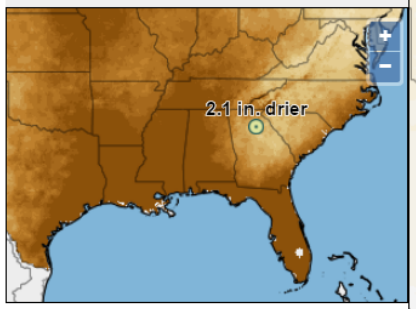
? About the Side Maps

Multi-Model Mean



Lowest Likely Change

ENLARGE



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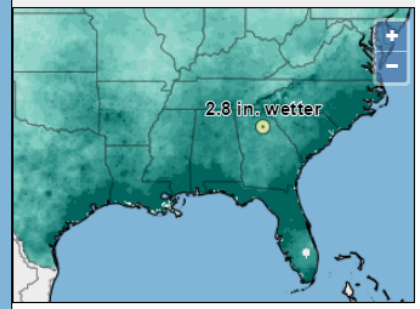

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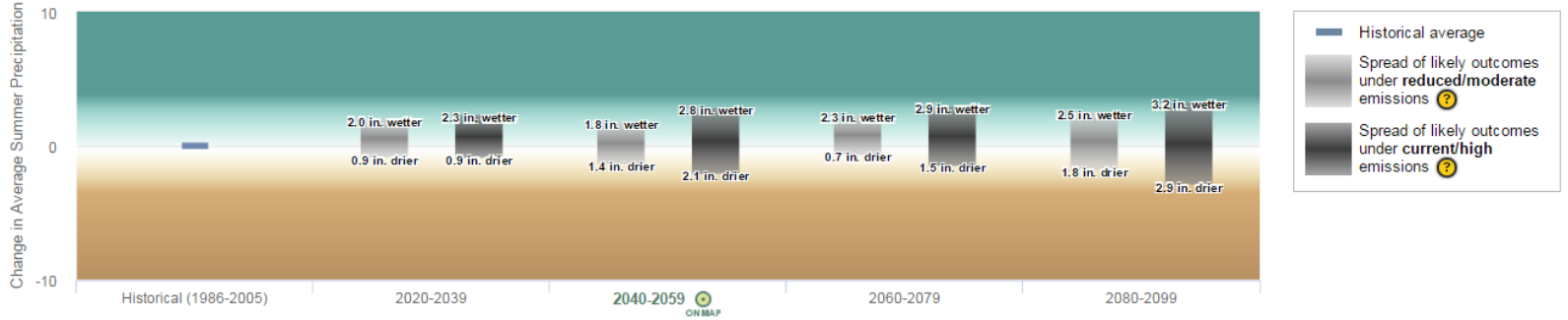


Source Ranges for Greater Productivity

? About This Tool

Map Display: Historical Hardiness Zones | Location-Specific Ranges

Future Emissions: Current Levels (High)

Seedling Source Ranges for a 20-Year Stand at Your Selected Location

Future Emissions: Current Levels (High)

The maps below show the current ranges of projected future temperatures for your selected location.
***Choose any time period below** to view details like the 5°F cold tolerance range.*

PLANTING PERIOD: 1986-2005 | 2010-2029 | 2020-2039 | 2030-2049 | 2040-2059 | 2060-2079 | 2080-2099

5° range

Show all time periods

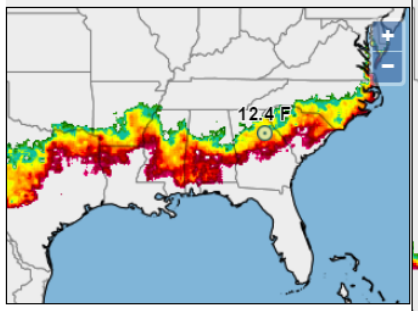
Location: In Oglethorpe County, GA (33.75°N 83.21°W)

To select a location, click on the map or enter your coordinates: 33.75 °N, 83.21 °W Go

? Map Help

? About the Side Maps

Lowest Likely Temperatures

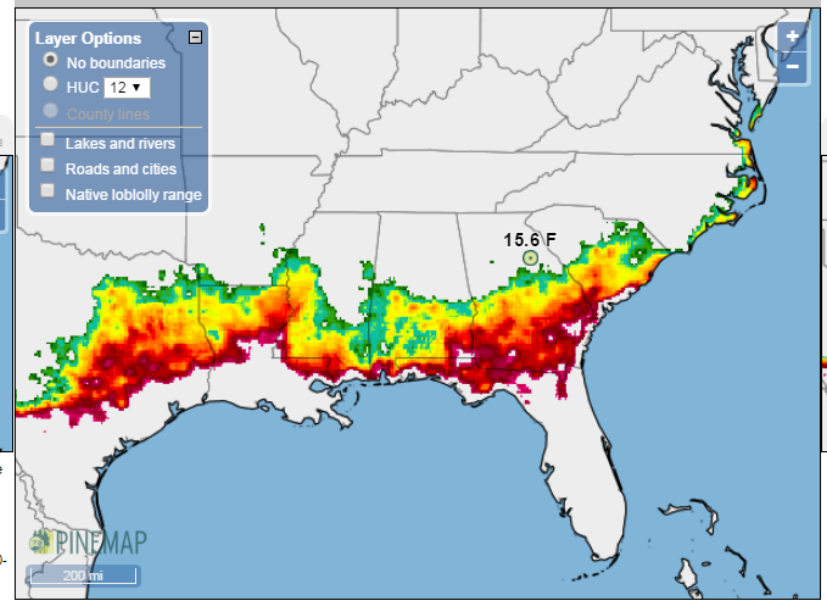


Current range of cold tolerance for temperatures in the projected 2020-2039 period

11°F 12.4°F 13°F 14°F 15°F 16°F 17°F

* This is the lowest likely temperature for your location in the 2020-2039 period given emissions at current levels (high)

Multi-Model Mean

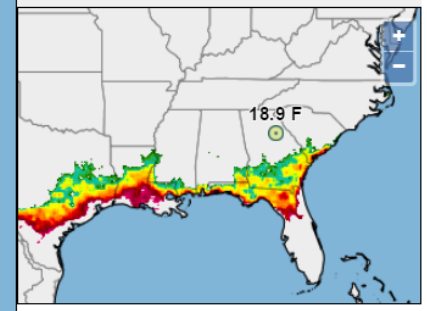


Current range of cold tolerance for temperatures in the projected 2020-2039 period

15°F 15.6°F 17°F 18°F 19°F 20°F 21°F

* This is the multi-model mean temperature for your location in the 2020-2039 period given emissions at current levels (high)

Highest Likely Temperatures



Current range of cold tolerance for temperatures in the projected 2020-2039 period

18°F 18.9°F 20°F 21°F 22°F 23°F 24°F

* This is the highest likely temperature for your location in the 2020-2039 period given emissions at current levels (high)

Other Resources

- USDA Plant Hardiness Zones
- Schmidtling, Ronald C. (2001) **Southern Pine Seed Sources.** Gen. Tech. Rep. SRS-44.

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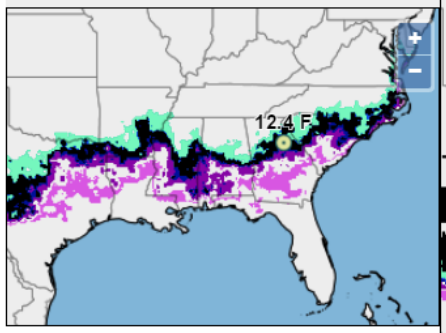

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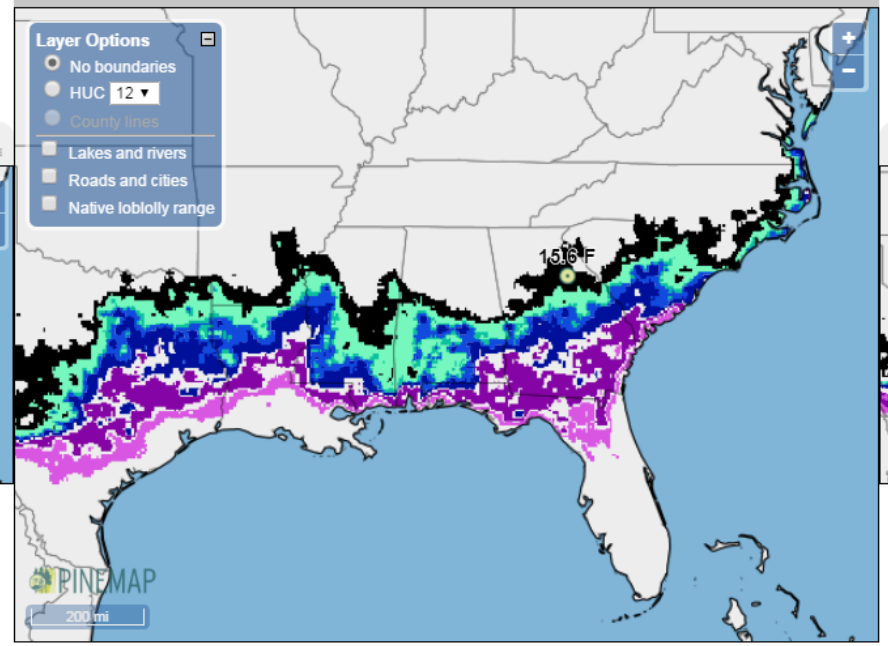
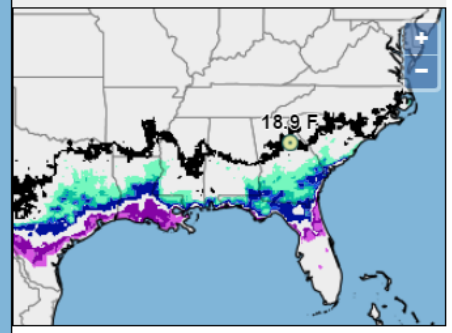


Highest Likely Temperatures



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For more information on dynamic hardiness zones, contact Dr. Gary Peter at the University of Florida.