PINEMAP
The Pine Integrated Network: Education, Mitigation and Adaptation Project

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Current innovations and opportunities in forest management and productivity Rotura, New Zealand, April 6-8th

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

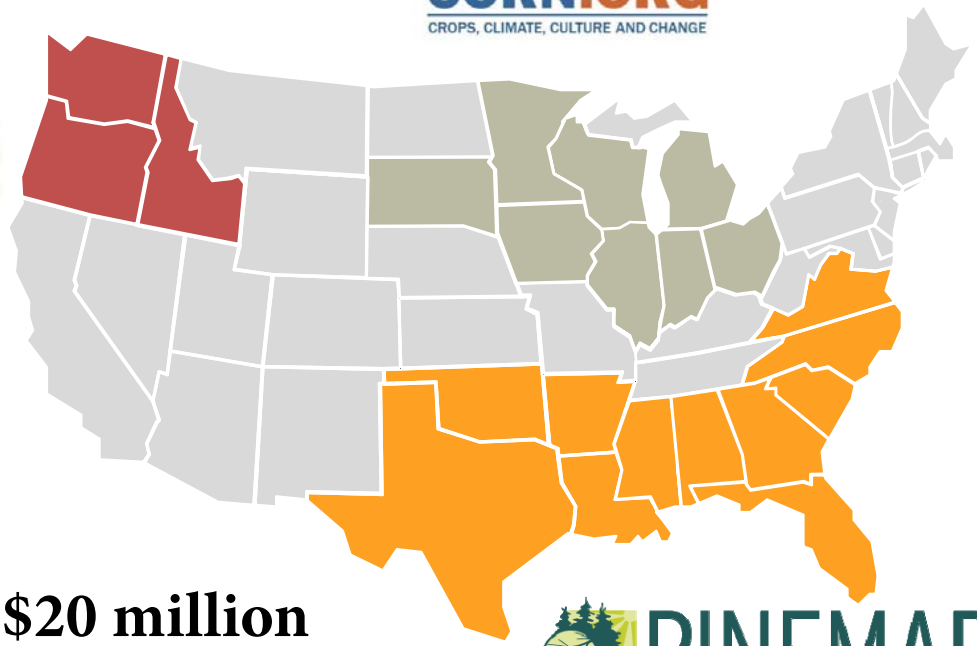
Prescribed, Outcome-Based Program

- **2010 USDA Request for Proposals**: “Reduce the use of nitrogen fertilizer by 10% and increase carbon sequestration by 15% through resilient agricultural production systems under changing climate by 2030.”

Wanted:
Wheat
Corn
Pine

SUSTAINABLE CORN.ORG
CROPS, CLIMATE, CULTURE AND CHANGE

REACCH
Regional Approaches to Climate Change – Pacific Northwest Agriculture



5-year projects

Funding level of $20 million

PINEMAP

PINEMAP leveraged existing University-Industry cooperatives

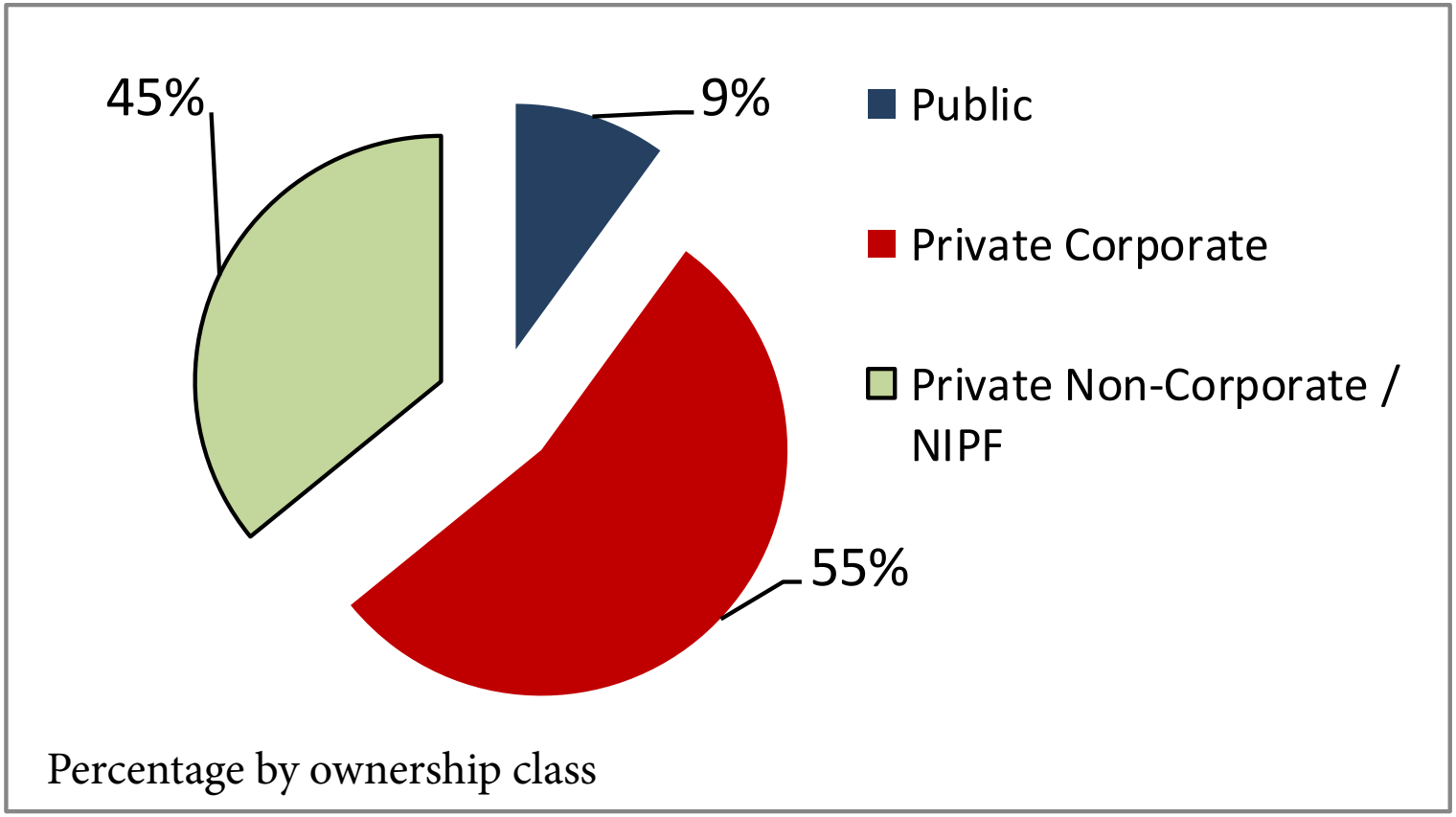
Research Cooperative	Host University (year founded)
Cooperative Forest Genetics Research Program	University of Florida (1953)
Cooperative Tree Improvement Program	North Carolina State University (1955)
Forest Biology Research Cooperative	University of Florida (1996)
Forest Modeling Research Cooperative	Virginia Polytechnic Univ. (1979)
Forest Productivity Cooperative	Virginia Polytechnic Univ. / NC State Univ. (1969)
Plantation Management Research Cooperative	University of Georgia (1975)
Southern Forest Resource Assessment Consortium	North Carolina State University (1994)
Western Gulf Forest Tree Improvement Program	Texas A&M Univ. / Texas Forest Service (1969)

PINEMAP Project Team

Lead Investigators: Tim Martin and Tom Fox

57 Principal Investigators
23 Research and Technical Staff
38 Grad Students
7 Postdocs
At 11 land grants universities + USFS

Focused on large landowners and pine plantations



Percentage by ownership class

Research Needs of Target Landowners

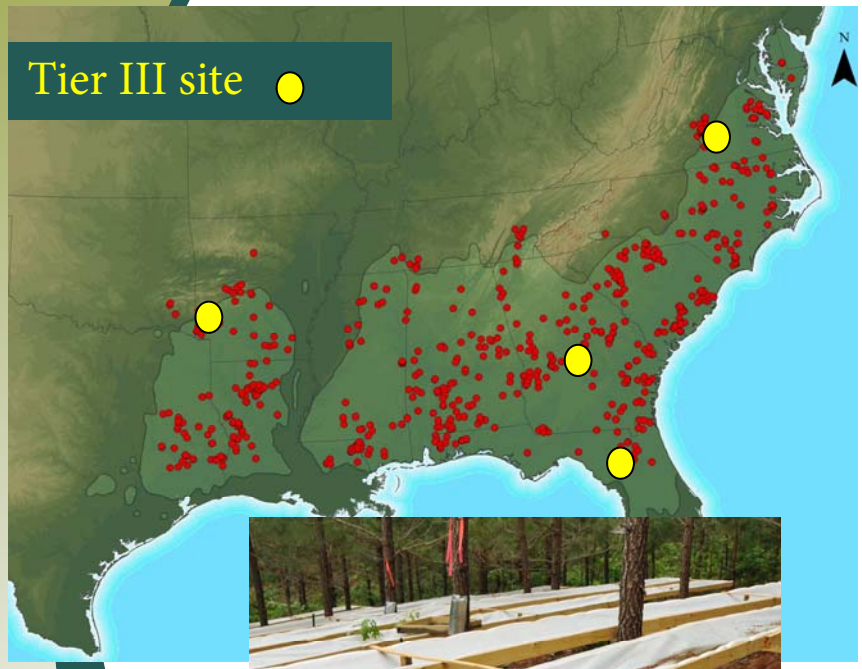
Question: *Please rate the importance to your organization of research on the following potential impacts of climate variability and climate change.*

Research	Important/ Very important
Changes in ***forest growth and productivity***	**92%**
Changes in ***timber supply***	**79%**
Changes in ***land values and land use options***	**70%**
Changes in forest management risk associated with the ***intensity, severity, or magnitude of forest insect or disease outbreaks***	**64%**
Changes in ***abundance and ranges of invasive species***	**49%**
Changes in forest management risk associated with ***intensity, severity, or magnitude of forest fires***	**44%**
Changes in ***phenology***	**41%**
Changes in forest management risk associated with ***extreme weather events (heavy winds, lightning, hurricanes, drought)***	**34%**

PINEMAP Approach

- Synthesize growth and genetics data from existing cooperative research.
- Incorporate this data into existing models of pine function.
- Investigate key uncertainties regarding climate and management effects on ecosystem carbon cycling (e.g. water availability x fertilization)
- Provide this information to professional foresters in a useable format.

Synthesis and experimental networks



- **Tier I**: ~ 700 sites with previously unshared data.
- **Tier II**: 123 sites / 450 plots with newly-measured C and nutrient pool data
- **Tier III**: Four experimental sites manipulating H_2O and nutrient availability at intensively monitored sites

- Baselines + model parameterization and validation

PINEMAP Modeling

Stand level modeling

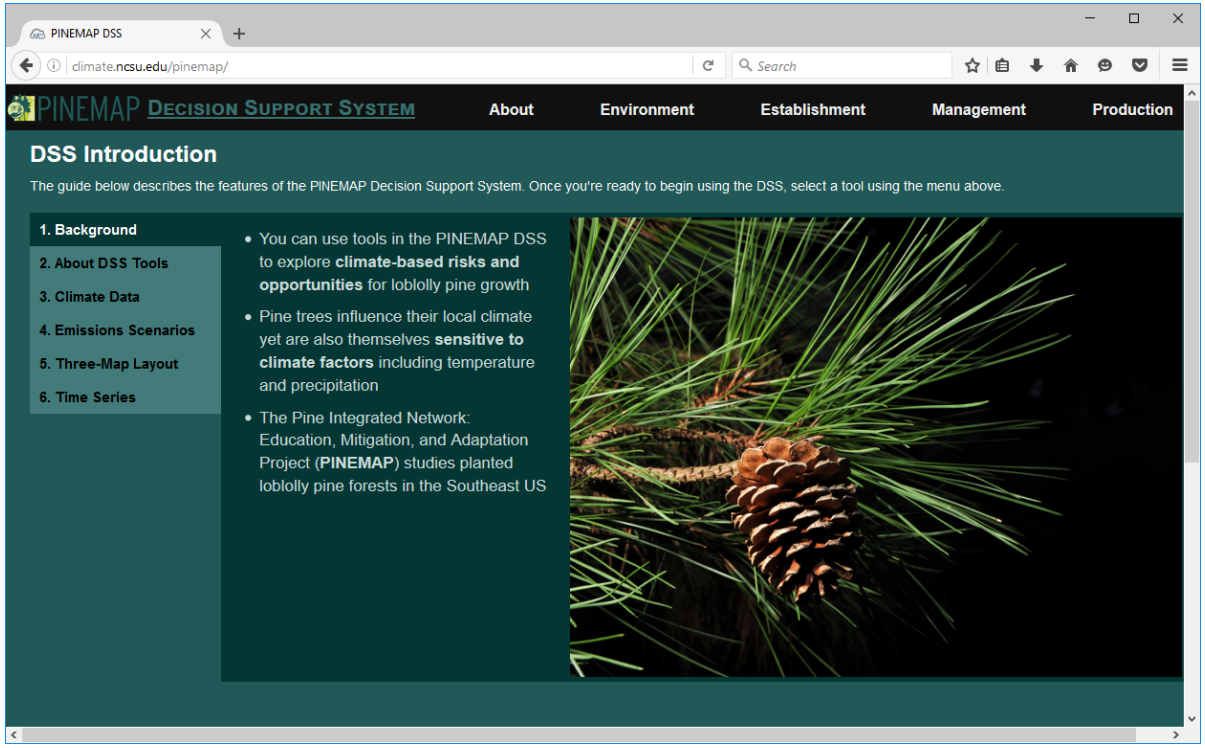
- Physiological Principles Predicting Growth (3-PG)
- Growth and Yield (climate-responsive)

Regional level modeling

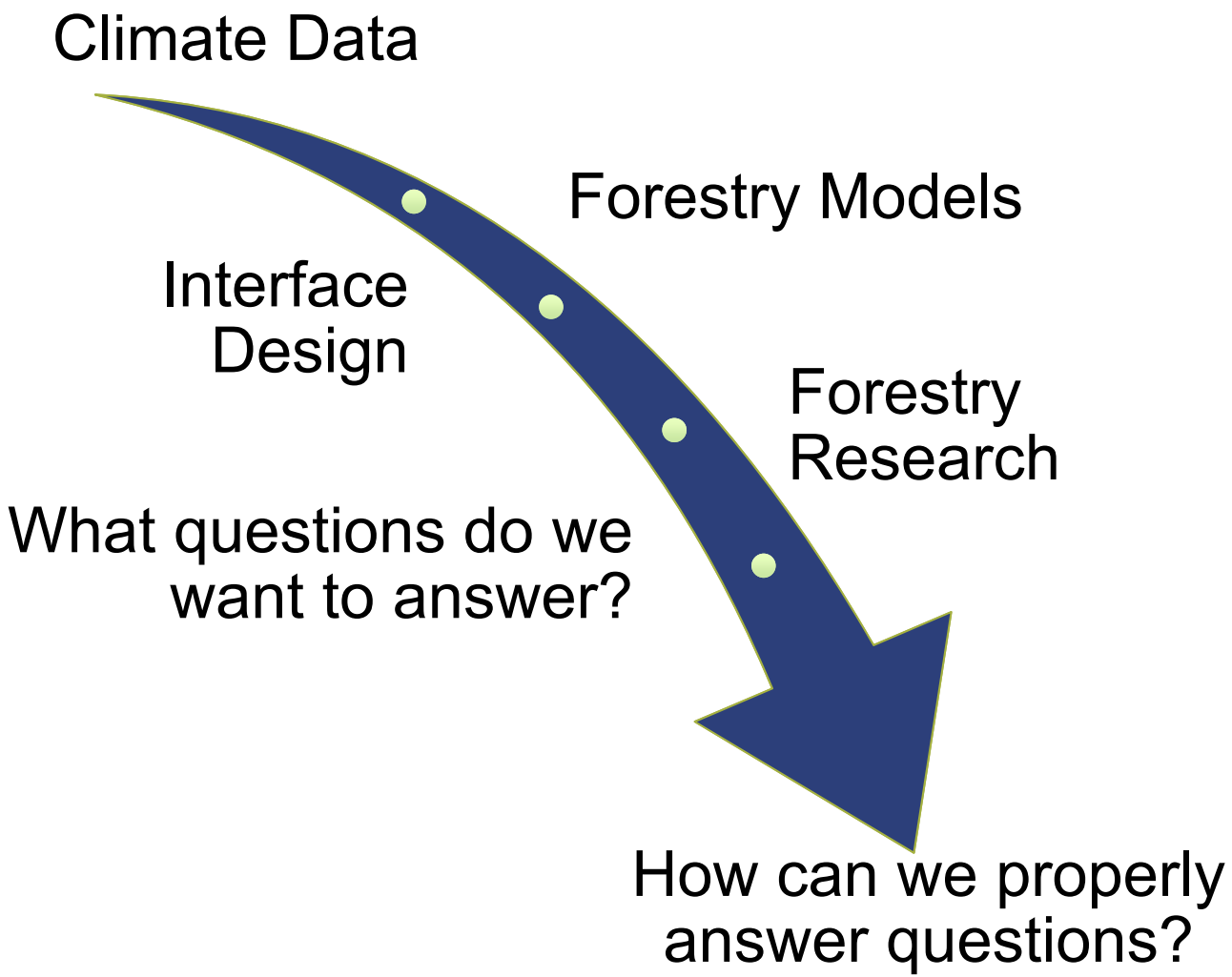
- Water Supply Stress Index (WaSSI)
- Community Land Model (CLM-BGC)
- Sub-regional Timber Supply Model (SRTS)

Decision Support System (DSS) http://pinemapdss.org

- Primary outlet for PINEMAP tools and resources to help users *identify opportunities* and *mitigate risk* associated with changing and variable climate
- Intended for professional foresters



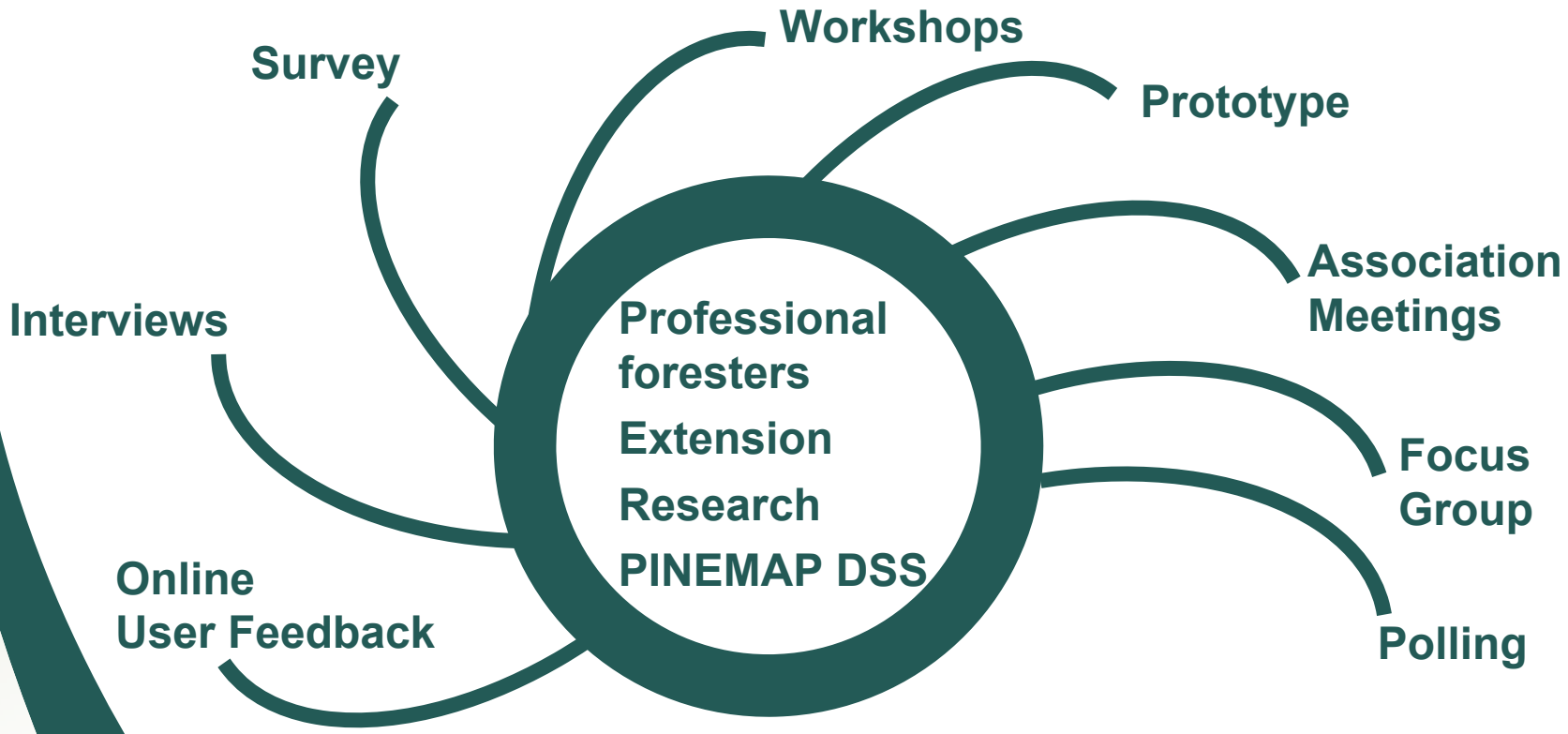
Steps in developing DSS



Slides courtesy of the State Climate Office of NC

Iterative process of DSS development

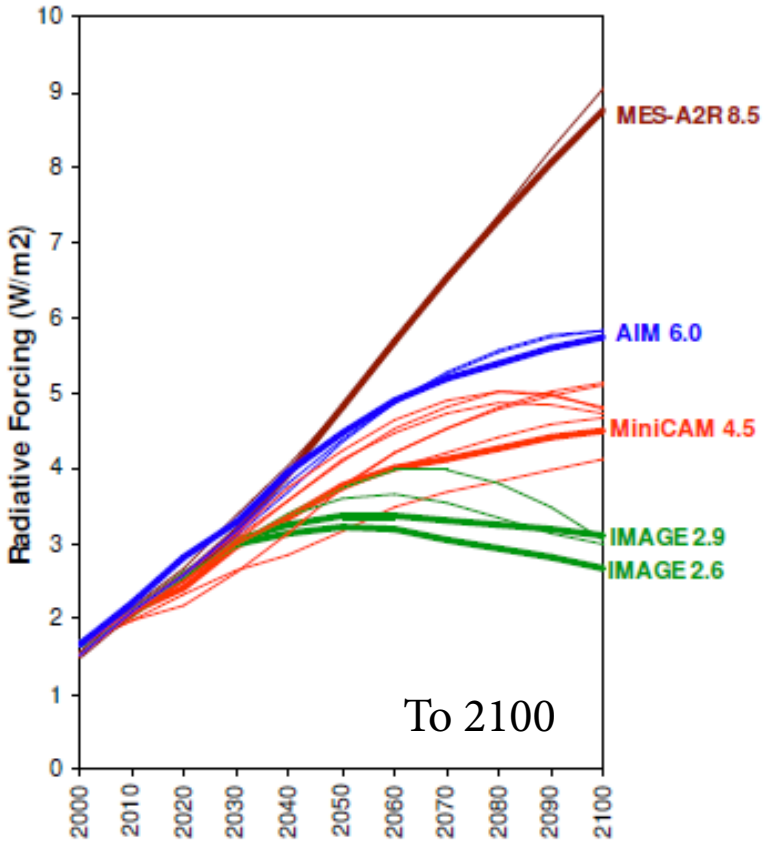
Southeast Climate Consortium multi-feedback loop model:



Slides courtesy of the State Climate Office of NC

Climate Model Projections

- Average of 20 Global Climate Models (GCMs)
- Output generated for a High (8.5) and Low (4.5) Representative CO_2 Concentration Pathway (RCP)



Slide courtesy of Dr. Adrienne Wootten, South Central CSC

Climate-Related DSS Output

Precipitation:

- Summer Precipitation

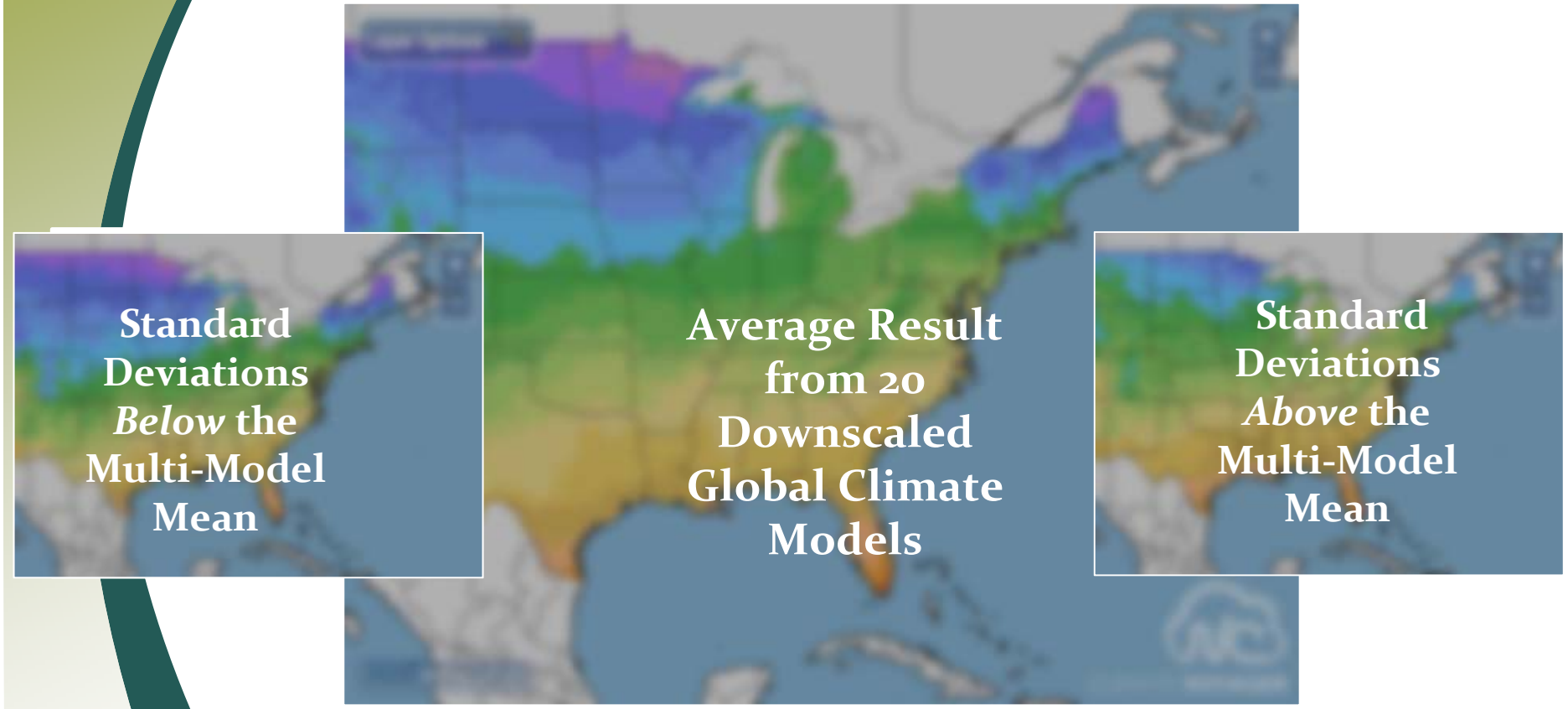
Temperature:

- Number of Days with Min Temp Below Certain Thresholds
- Summer Temperature

Drought:

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

Three-Map Layout

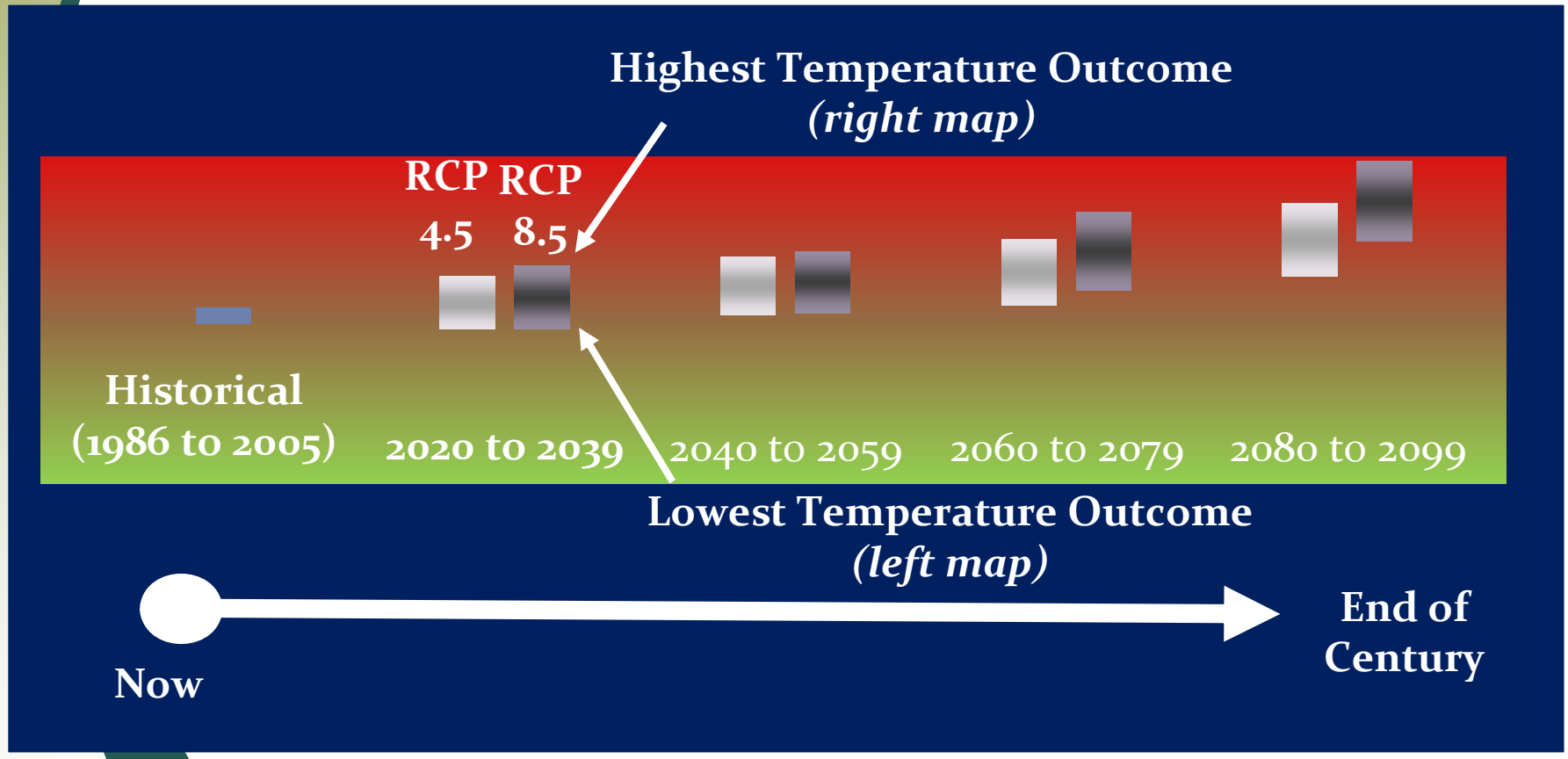


Model Spread
(95% of all Guidance)

Slides courtesy of the State Climate Office of NC

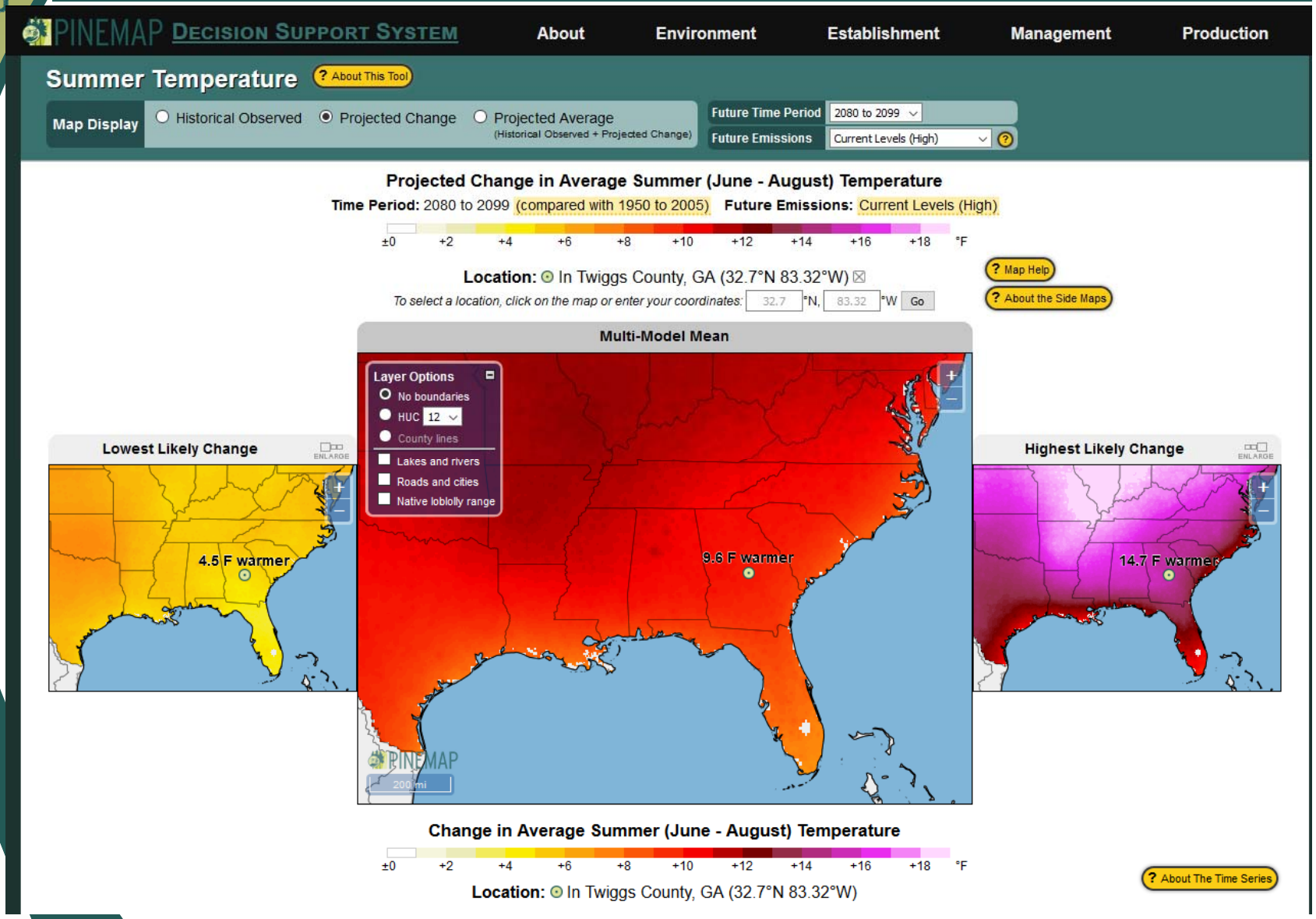
Time Series Plot

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



Slides courtesy of the State Climate Office of NC

Summer Temperature

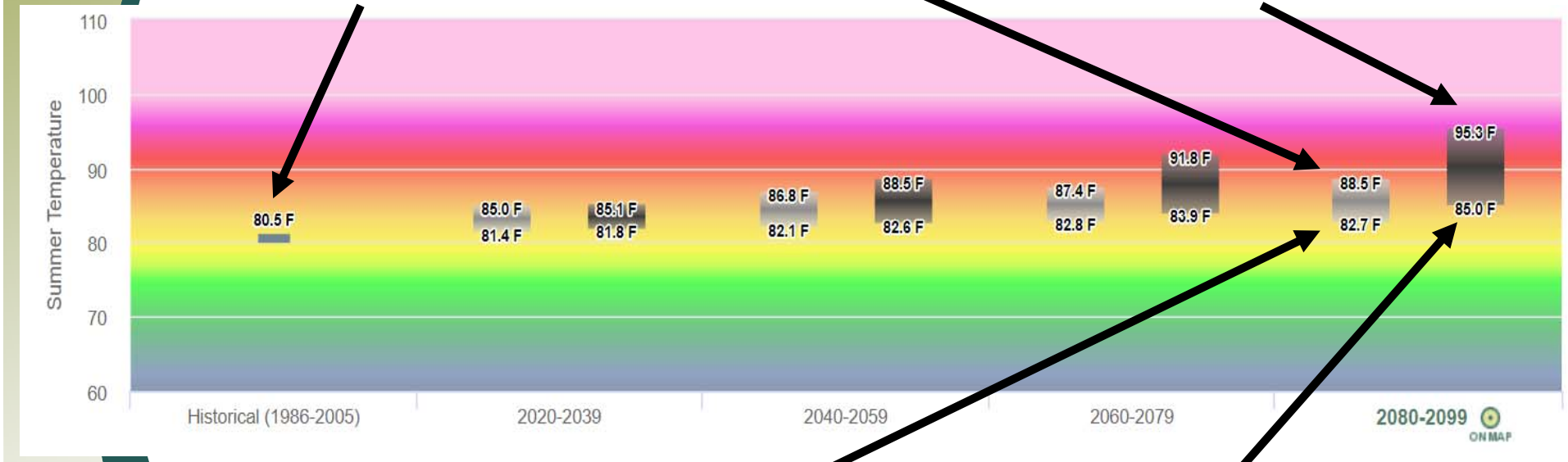


Summer Average Temperature

Average summer temperature (1950-2005) 26.9 °C

RCP 4.5, greatest temperature change 33.1°C

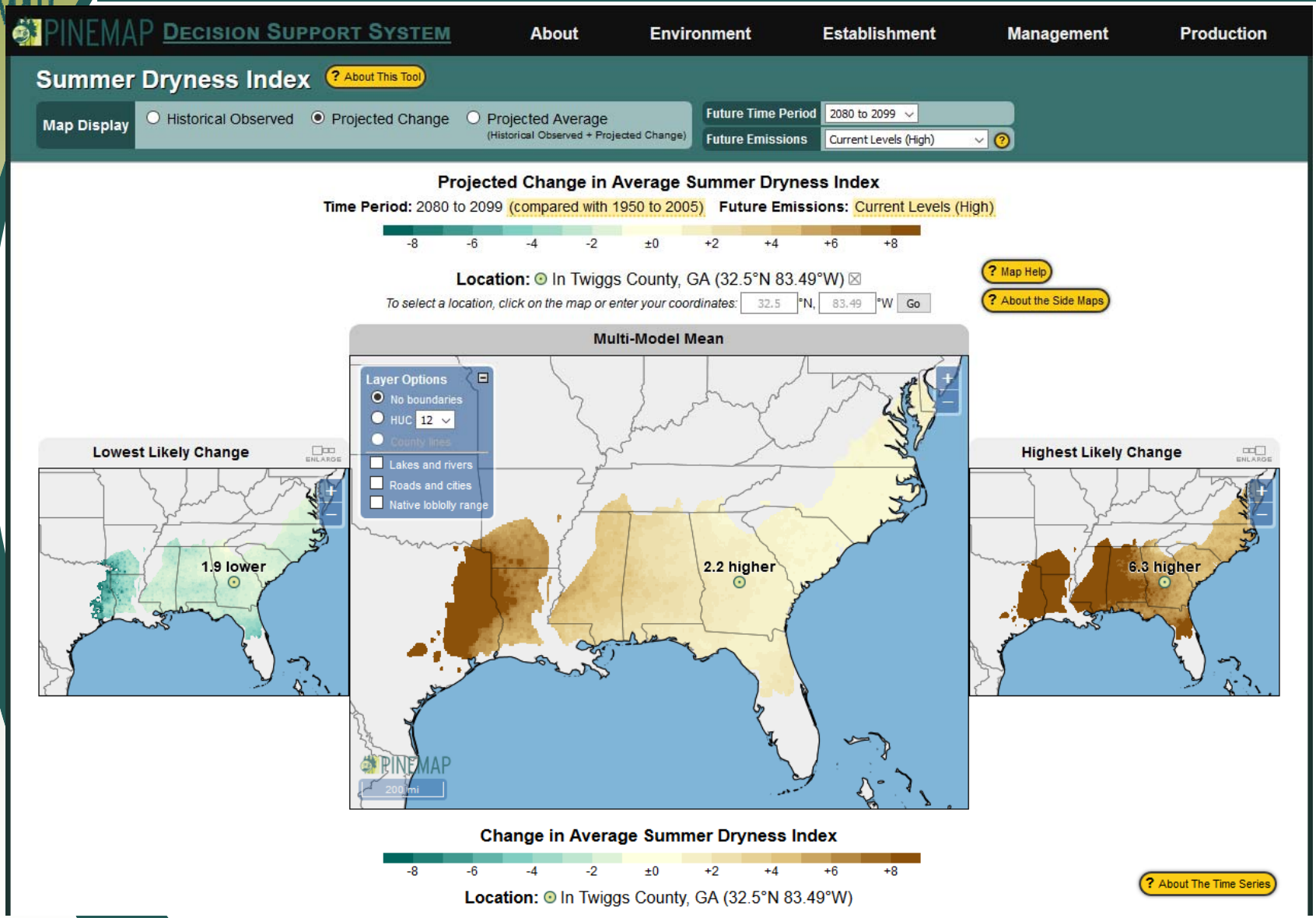
RCP 8.5, greatest temperature change 35.2°C



RCP 4.5, lowest temperature change 28.2°C

RCP 8.5, lowest temperature change 29.4°C

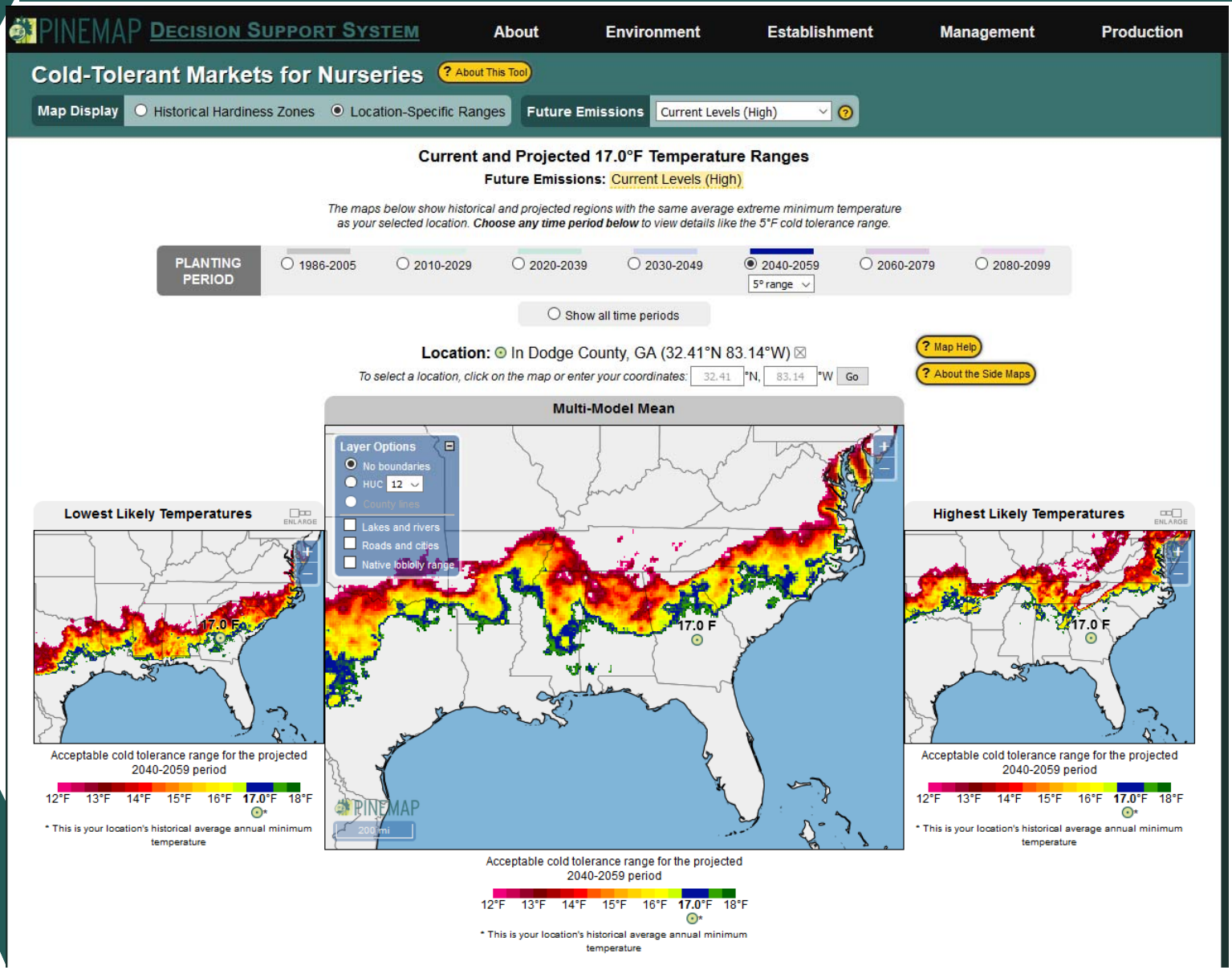
Summer Dryness Index



Biological/Ecosystem Service Outputs of DSS

- Seedling Deployment (Dynamic Hardiness Zones)
  - Cold-Tolerant Markets for Nurseries
  - Source Ranges for Greater Productivity
- Net Primary Production (3-Pg)
- Water yield and Gross Ecosystem Production (WaSSI model)
  - Climate driven changes in yield
  - Currently not connected to management

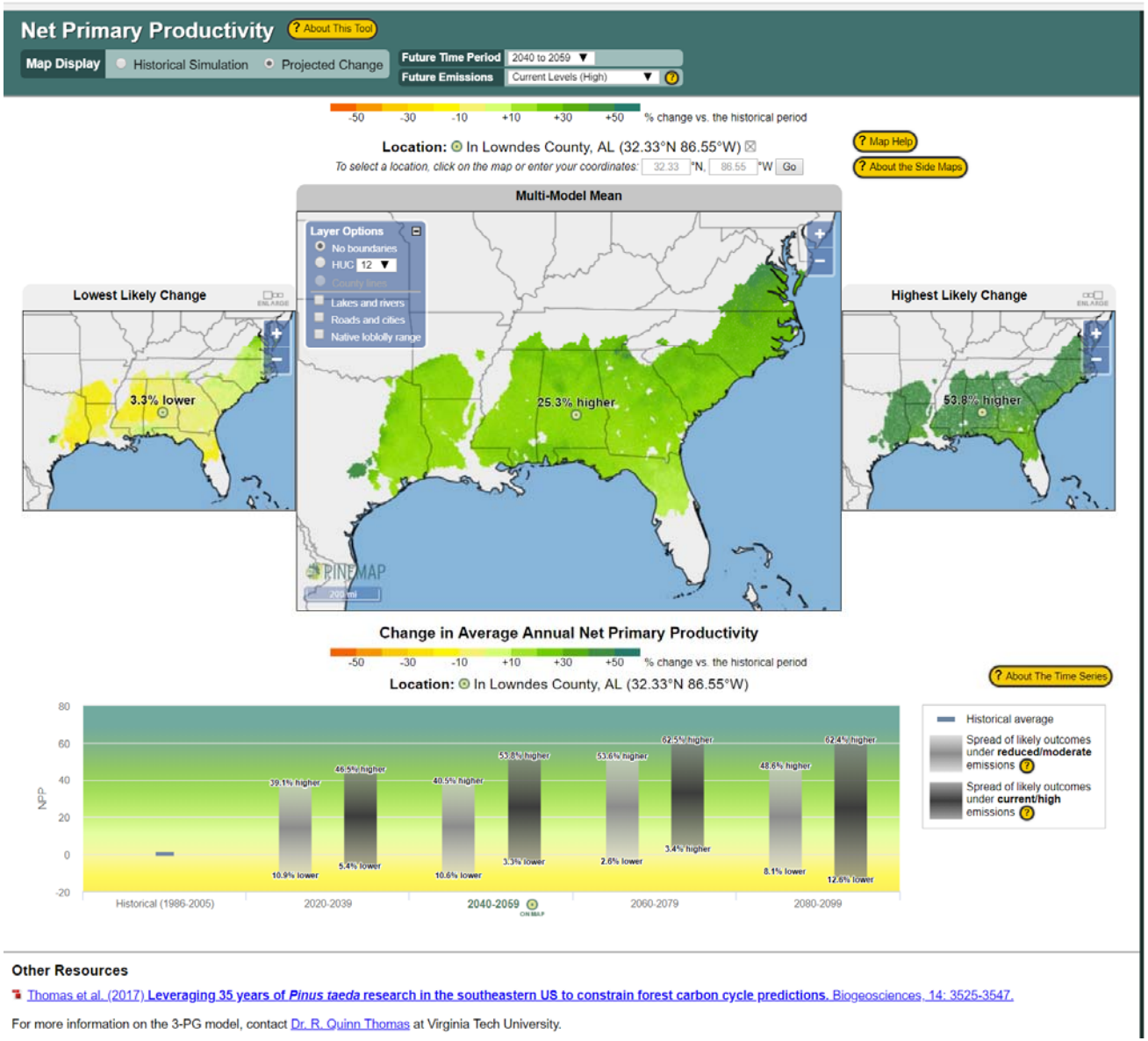
Deploying seedlings to the north in the future



Early Insights: Carbon

- Models suggested that CO_2 fertilization and warming in cold regions will increase carbon sequestration by targeted 15% amount out to 2030 (Gonzalez-Benecke 2017).

Net Primary Production



Other Resources

Thomas et al. (2017) **Leveraging 35 years of *Pinus taeda* research in the southeastern US to constrain forest carbon cycle predictions.** Biogeosciences, 14: 3525-3547.

For more information on the 3-PG model, contact Dr. R. Quinn Thomas at Virginia Tech University.

Scientific Insights: Nitrogen

Nitrogen Cycling

- Brian Strahm, Tom Fox and Jay Raymond had an ongoing project that suggested slow release N fertilizers could reduce N losses and improve N efficiency (Raymond et al. 2016).

- Ongoing research is determining whether these fertilizers result in increased productivity.

Scientific Insights: Climate Sensitivity x Management

- Fertilization decreases NPP sensitivity to reduced moisture (Will et al. 2015; Maggard et al. 2017)

- Net ecosystem production was also increased by fertilization because of increased NPP ***and suppressed soil respiration*** (Bracho et al. in press).

Questions from Dr. Clinton

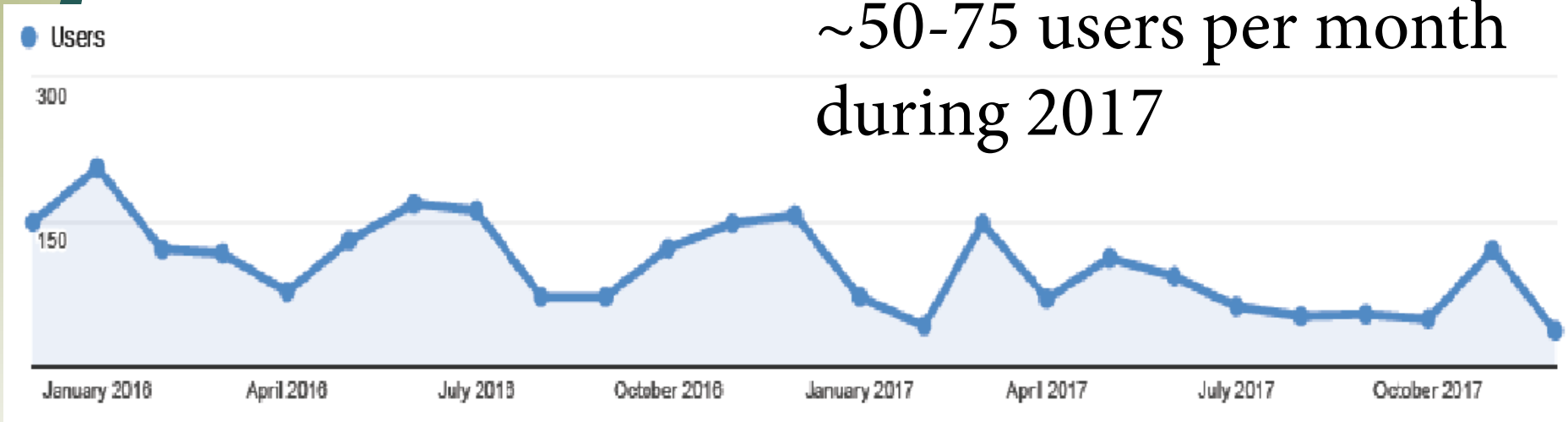
- Were project goals achieved (or not)…?
- What is possible in terms of impacts during and after the life of the project?

Achievement of goals

- Developed accessible tool for assessing plantation productivity potential through data-model integration.
- Reduced uncertainty in how climate change might affect plantation productivity.
- Nitrogen cycling research suggests pathways for reducing N losses.

Ongoing User Activity with DSS

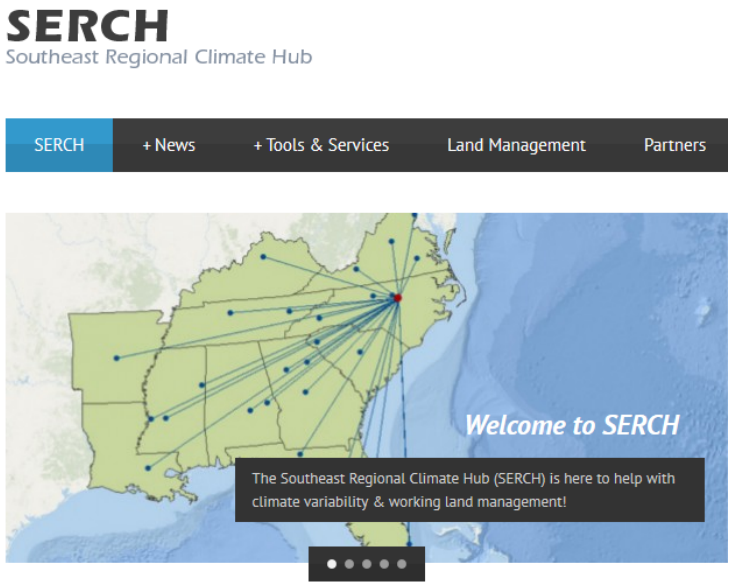
- Google Analytics Tracking interaction with DSS



~50-75 users per month during 2017

PINEMAP impact

- Continued support and refinement of DSS and underlying models
- Incorporation of mechanistic growth modeling into cooperative research



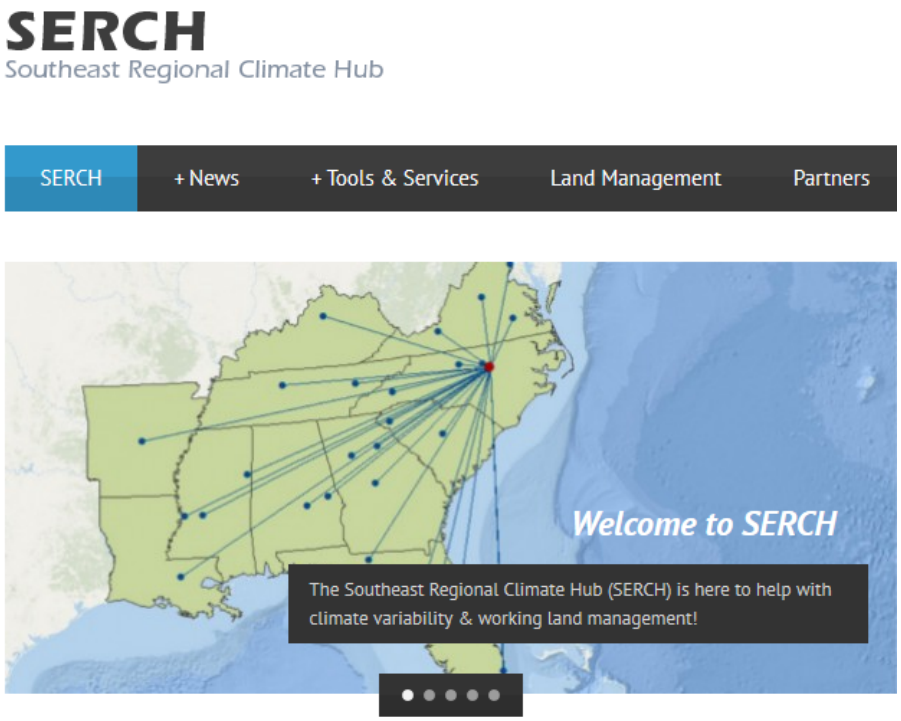
USDA funded project
https://www.climatehubs.oce.usda.gov/hubs/southeast

PINEMAP Goals

To create, synthesize, and disseminate the necessary knowledge to enable southern forest landowners

- to harness pine plantation productivity to mitigate atmospheric $CO_{2,}$
- to more efficiently utilize nitrogen and other fertilizer inputs,
- and to adapt their forest management approaches to increase resilience in the face of a changing climate.

Ongoing PINEMAP Outreach



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- Southeast Regional Climate Hub will be central to supporting DSS efforts
- 30-year outcome goals, 5-year project
- Data and tools
- Outreach and educational resources
- Network coordination
- Cooperative advisory board consisting of coop directors will advise SERCH on outreach needs of corporate community

Integrative Research Focused on Outcomes

- Decision Support System development
  - Seed deployment tool development
  - Regional modeling runs: 3-PG, WaSSI,
- Regional measurements: ecosystem C fluxes; sap flow; soil respiration
- Genotyping and gene discovery
- Project Learning Tree educational module development
- Outreach / Extension / Tech Transfer
  - Corporate
  - Non-corporate
- Integrating modeling with economic analysis