



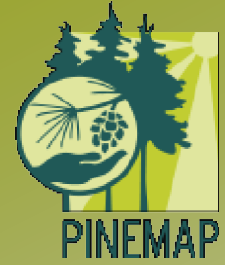
# PINEMAP climate scenarios and projection datasets

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Science Presentation

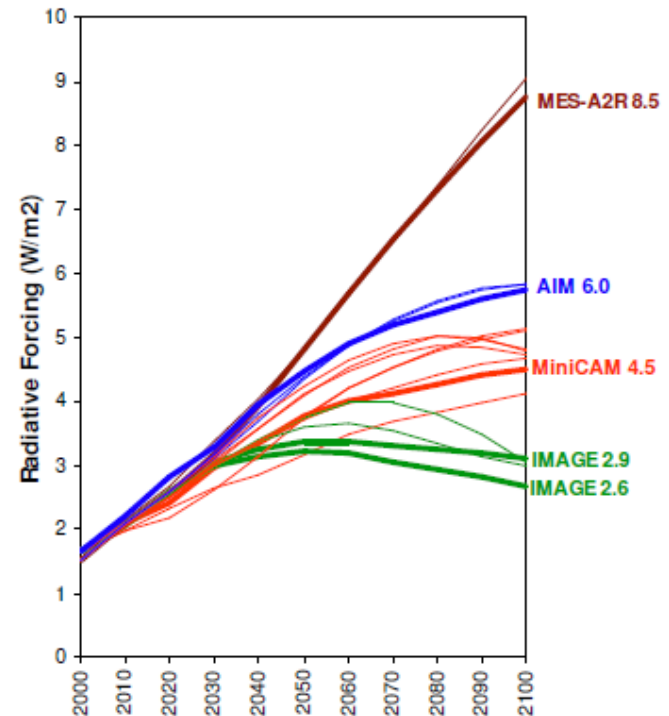
PINEMAP 2014 Annual Meeting | May 14—16, 2014



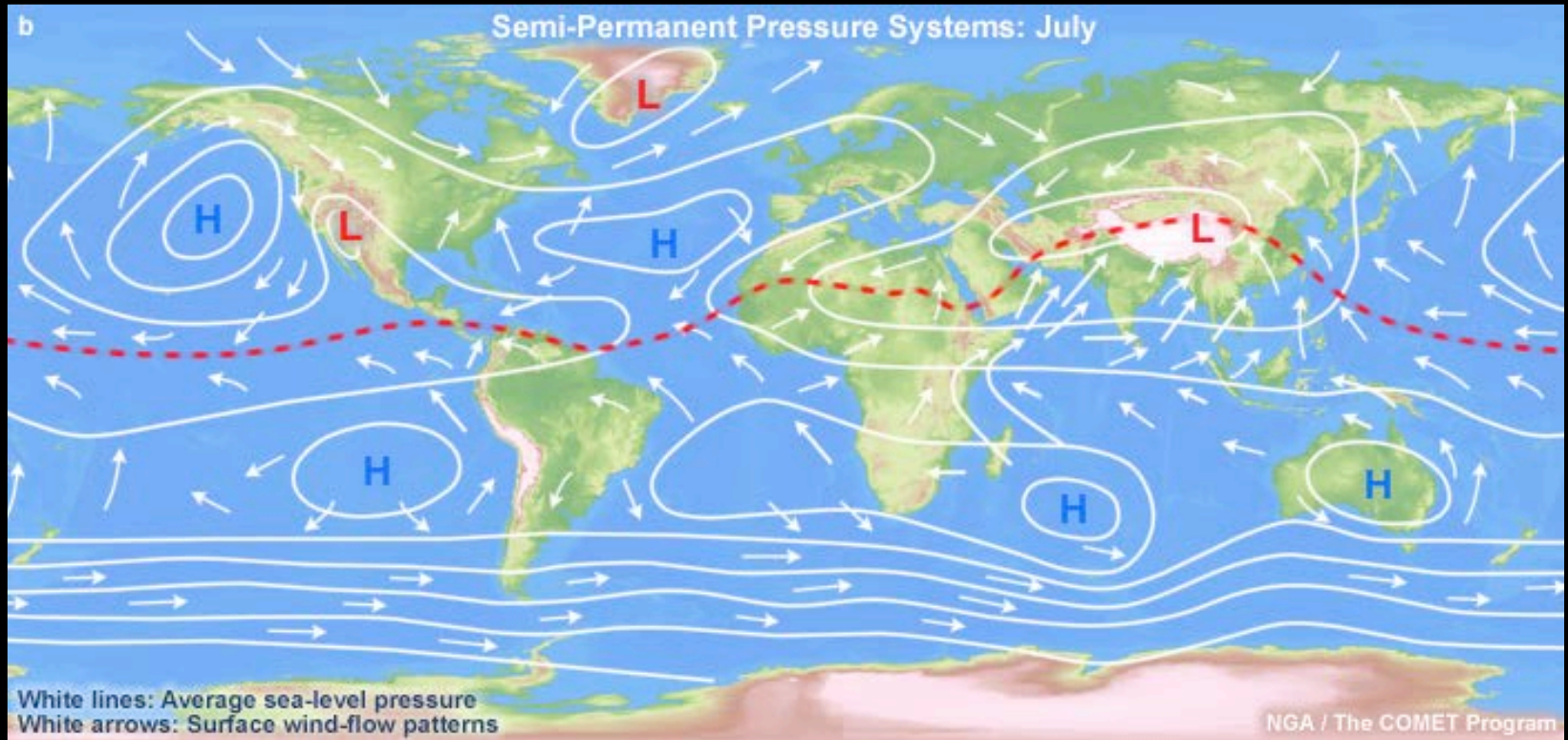
# Intro: Climate Model Projections

- Climate models 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<sub>2</sub> doubles?

Climate models are projections and dependent on the assumptions made about external forcing, such as changes in CO<sub>2</sub>.



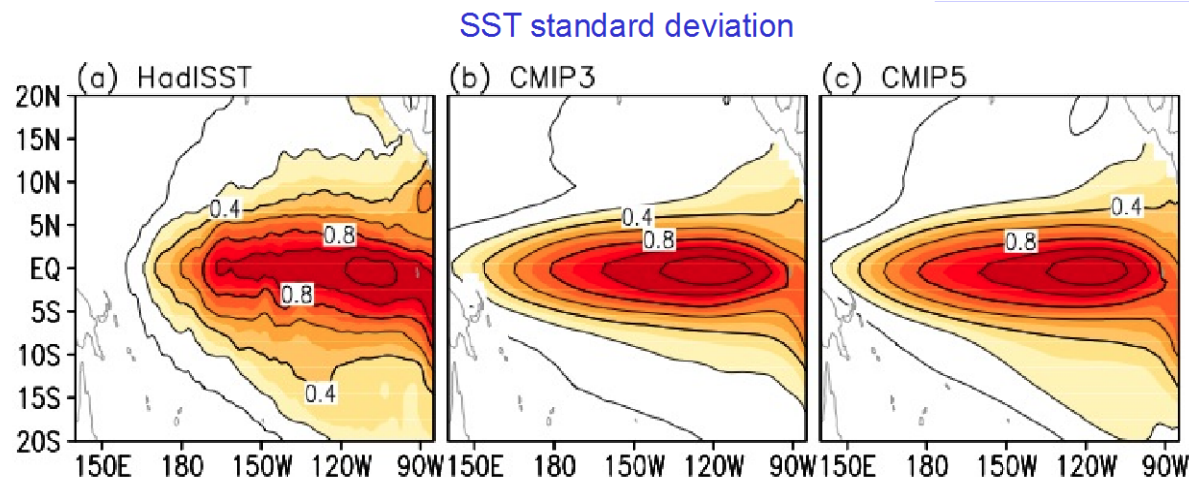
# What do GCMs do well?



- Global, continental general patterns
  - Mean Temperature, Temperature Trends, Broad atmospheric circulation
- Representation of some large-scale climate drivers within the climate system. (GCM natural variability differs regionally.)

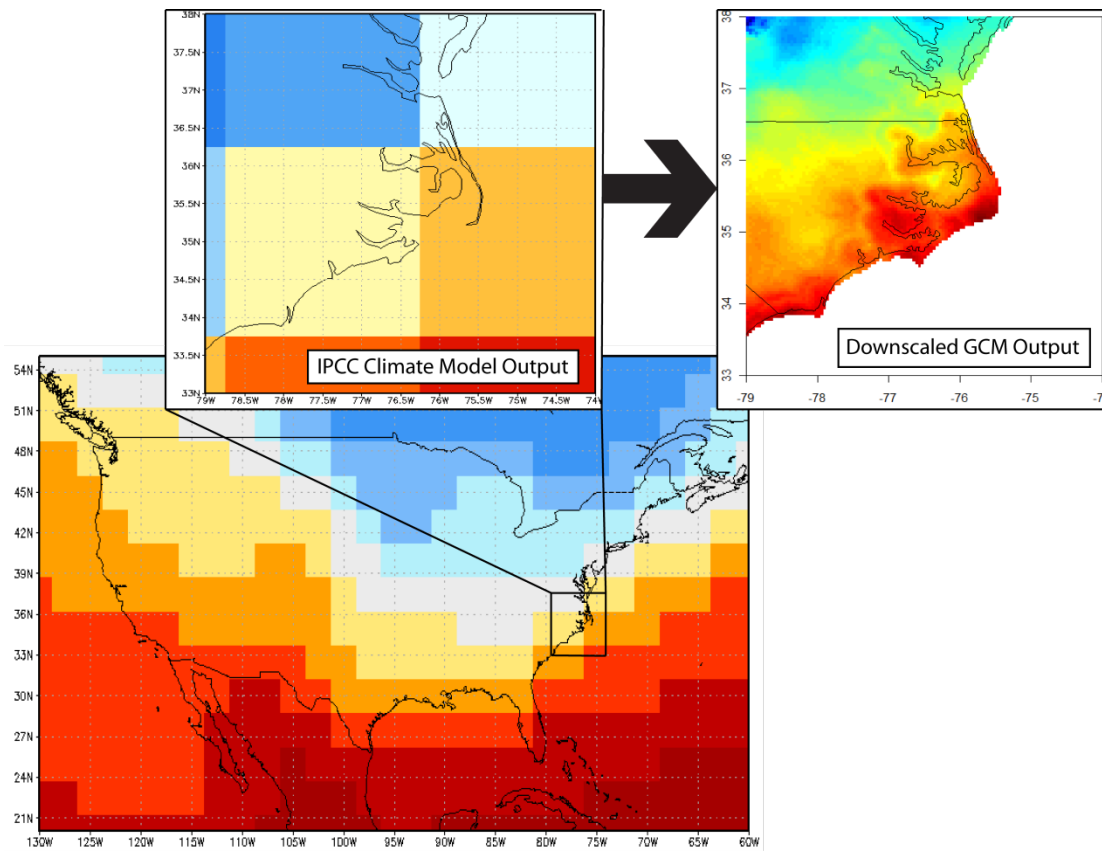
# What do GCMs not do well?

- Regional climate (topography, land cover, SST)
- Representing extreme events (i.e. storm intensity/duration)
- Representation of clouds
- Problems still exist with large-scale climate drivers
  - (e.g. ENSO: GCMs capture but problems w/ structure, timing)



# What is downscaling and why?

“the process of making the link between the state of some variable representing the large space and the state of some variable representing a much smaller space.”  
Benestad (2008)



Downscaling



Statistical

Dynamic



Based on statistical relationships between regional and global scale

Based on physical relationships similar to those in the Global Climate Models

# Downscaling

## Statistical

Pros – incorporate historical information, computationally inexpensive, flexibly crafted for specific purposes

Cons – assumes statistical relationships will be valid in the future, require a long observational record, affected by the errors in a GCM

BCSD  
SERAP  
MACA\*

\* = PINEMAP's climate projection dataset

## Dynamic

Pros – globally consistent, physically consistent, many parameters modeled,

Cons – computationally expensive, affected by errors in a GCM, must approximate the things that occur at a finer resolution (clouds, precipitation)

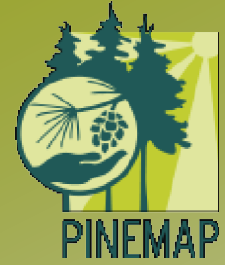
NARCCAP  
Hostetler  
CLAREnCE10



# Downscaling is not interpolation

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- Interpolation does not preserve physical relationships
- Downscaling resolves local climate processes
  - Localized precipitation
  - Topographic effects
  - Land surface influences

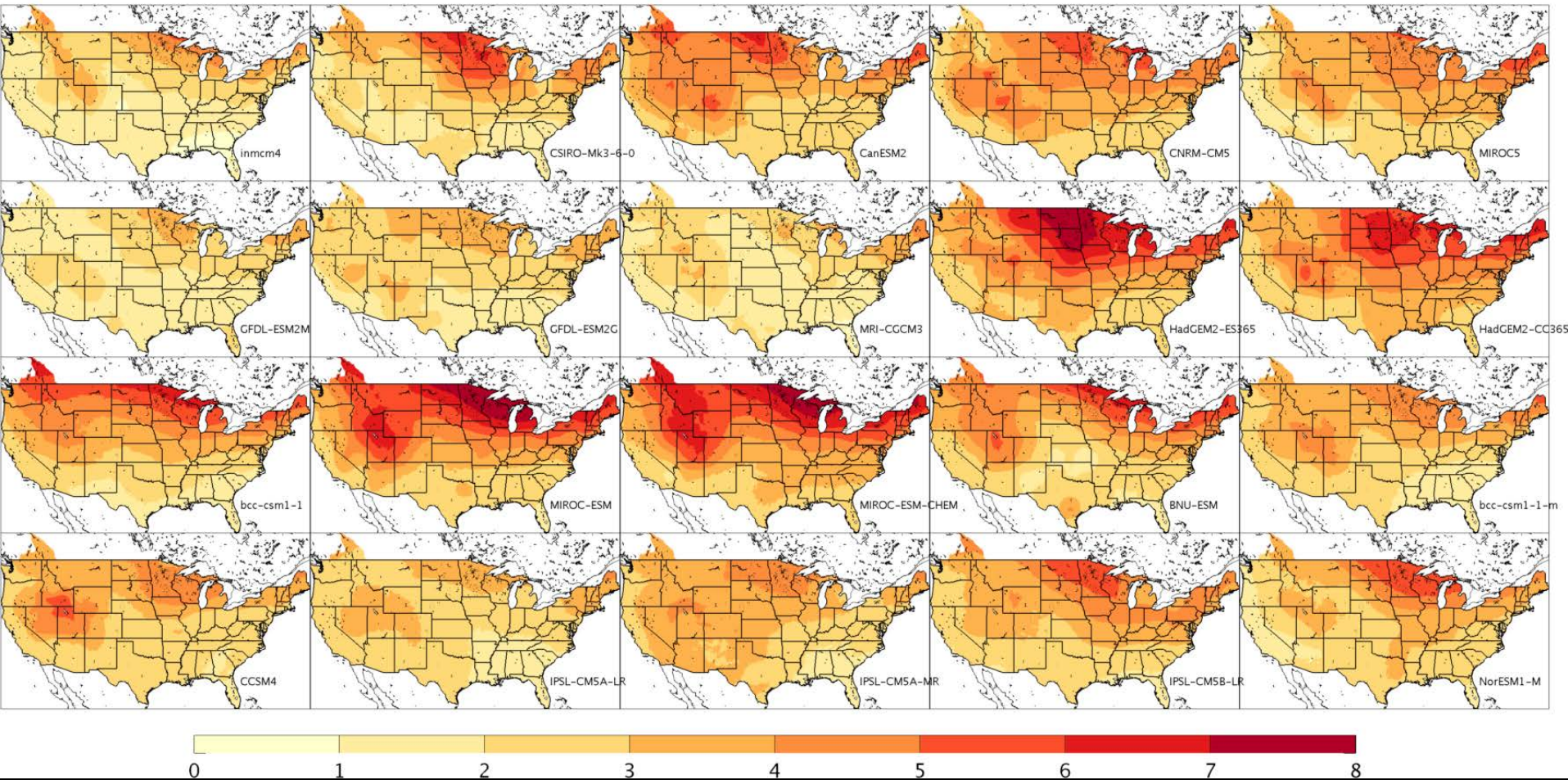


# Model Ensembles

- There is no best climate model – each has strengths and weaknesses
- Multiple climate models are often used together as an ensemble
- Using ensembles provides the best estimate of the climate
  - Reduce model internal variability because GCMs can have different response with slight changes in initial conditions.
  - Multi-model ensembles reduce error statistics because no single GCM represents all physical processes best.
- For example...

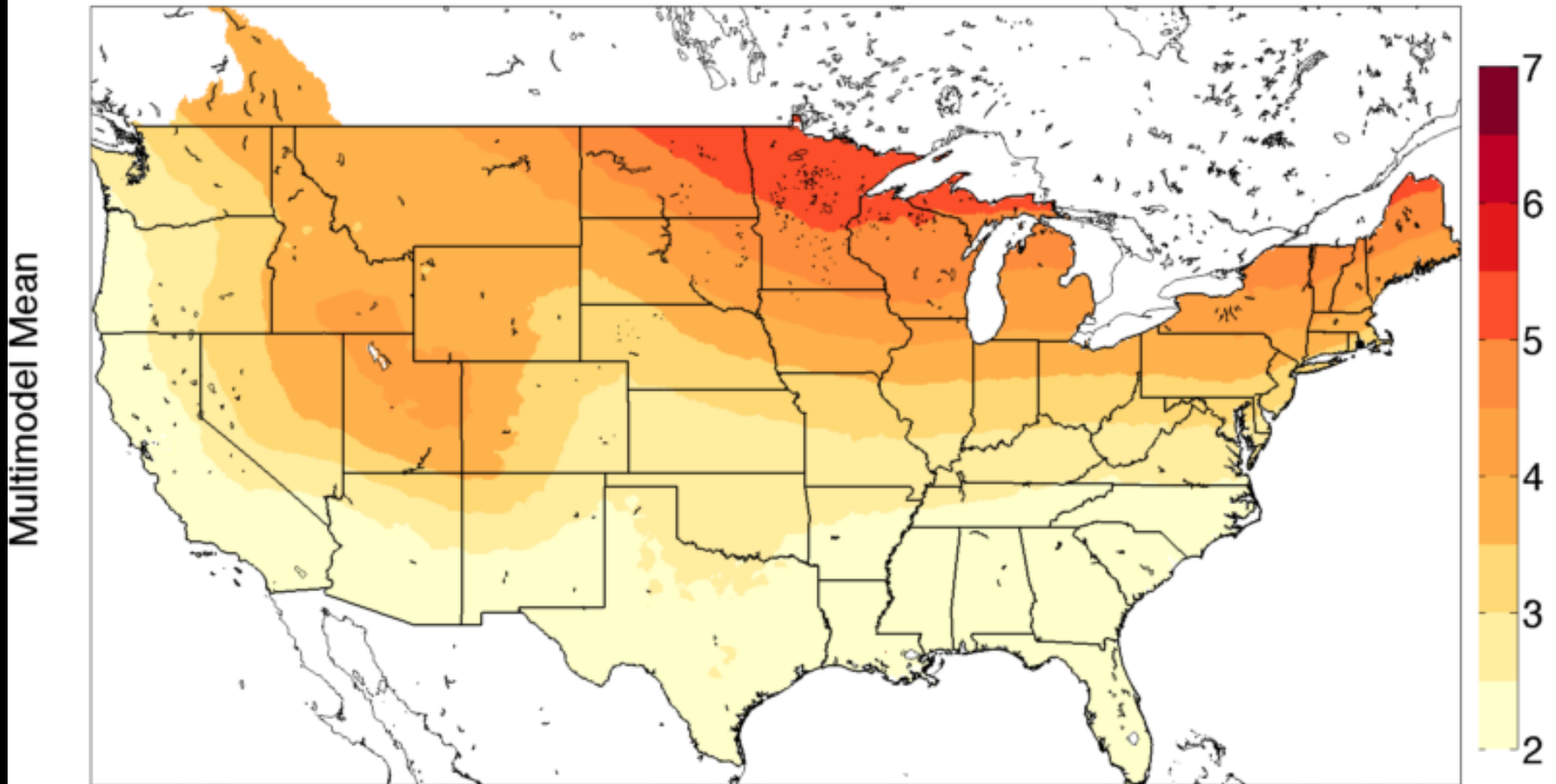
# Range of model projections

$\Delta$  Minimum Temperature Dec-Feb 2040-2069 vs. 1950-2005, RCP8.5: Units= $^{\circ}\text{C}$



# Multi-model mean

$\Delta$  Minimum Temperature Dec-Feb  
2040-2069 vs. 1950-2005, RCP8.5: Units= $^{\circ}\text{C}$





# Climate Model Summary

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- Long-term changes in global climate will have local impacts
  - Historical climatology likely not useful in 50 years
- Global models capture very broad changes
- Must downscale to simulate local changes
  - Downscaling needed to capture physically consistent changes
  - Use multiple models to characterize uncertainty



# PINEMAP's Climate Projection Dataset

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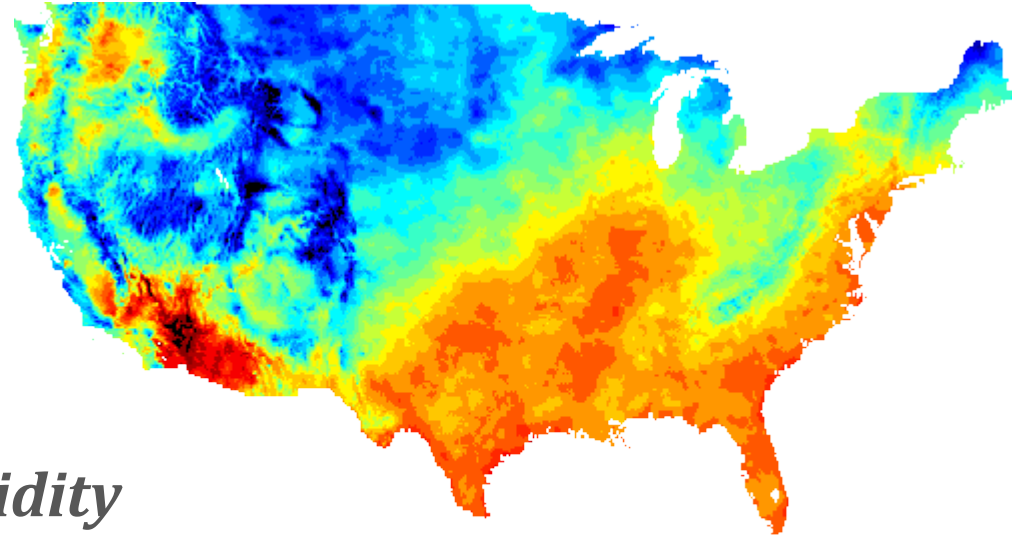
- Multivariate Adaptive Constructed Analogs (MACA) Downscaled Climate Data
  - Statistical downscaling method
  - Projections for “baseline”, 1950-2005, and for future time period, 2006-2100
  - 20 different GCMs used by IPCC 5<sup>th</sup> Assessment
  - Two different emission scenarios:
    - RCP 4.5 (moderate emissions)
    - RCP 8.5 (high emissions)

# PINEMAP's Climate Projection Dataset

MACA continued...

- Format: netCDF
- Variables:
  - accumulated precip
  - min/max air temp
  - *mean wind speed*
  - *mean specific humidity*
  - *surface downwelling shortwave radiation*
- Resolution: Daily, ~6km = ~6TB data
- MACA provides appropriate time and spatial resolutions for PINEMAP needs

*Example output: RCP4.5 projection of minimum temperature on July 4, 2030 downscaled with MACA from CanESM2 model*





# Application for PINEMAP

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- Multiple climate variables
  - Averages and extremes
  - Various time slices and seasons
  - Both emission scenarios
- Change between future and baseline
- Feeds into PINEMAP models  
(productivity, water, pest, markets, etc.)



# Climate Projection Products

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All projections are available now for all researchers

- This is just the beginning

Too much data for PINEMAP to fully explore, will focus on:

- annual avg temperature, annual precipitation, and mean annual extreme minimum temperature
- multi-model mean and extreme percentiles (10<sup>th</sup>, 90<sup>th</sup>) for each RCP (4.5 and 8.5) and time slice (1986-2005, 2021-2040, 2041-2060, and 2081-2100)
- **Overall, 20+ maps for each climate variable**

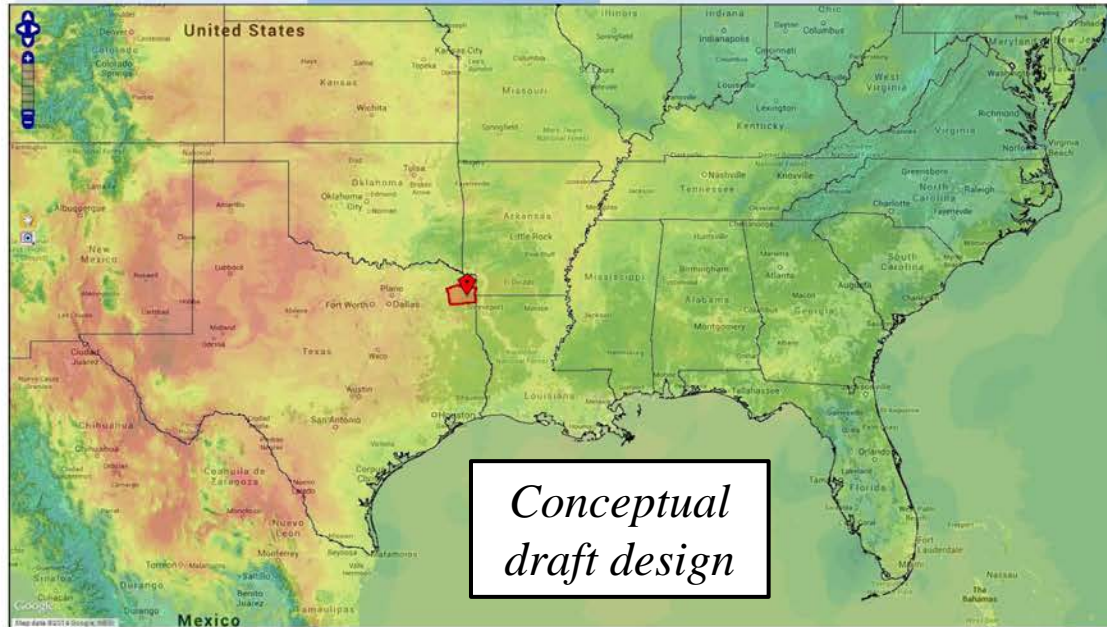
Select a tool: Extreme minimum temperature frequency ▾

Historical dataset (from 1986 to 2005):  
 Observations  
 Model baseline data

Future projections:  
 Period: 2061 to 2080 ▾  
 Season: Winter (DJF) ▾  
 RCP scenario: 4.5 ▾

Temp. threshold: 20°F ▾  
 Display

Minimum projected change Mean projected change Maximum projected change

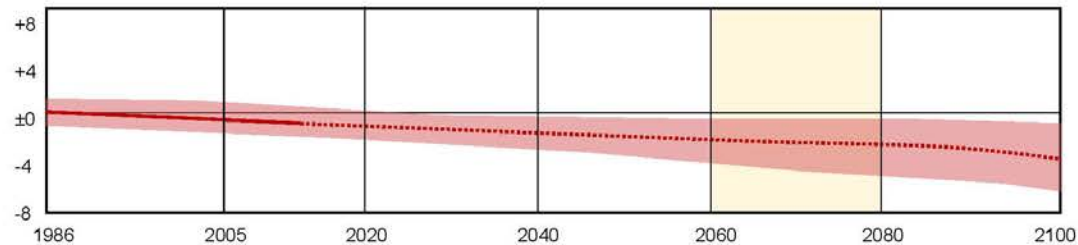


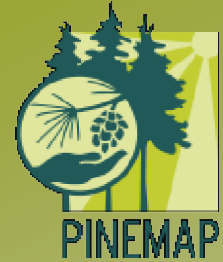
Mean projected change in days per year with minimum temperatures < 20°F for the period from 2061 to 2080 (reference period: 1986 to 2005)



◆ At your location:

Region: Cass County, TX      Baseline: 12 ± 3.2 days      Projected Change: -2.8 ± 2.1 days





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