manomet

Soaring Solutions. Grounded Science.

Climate Change and Cranberry Agriculture

Eric Walberg, Climate Services Director

Manomet

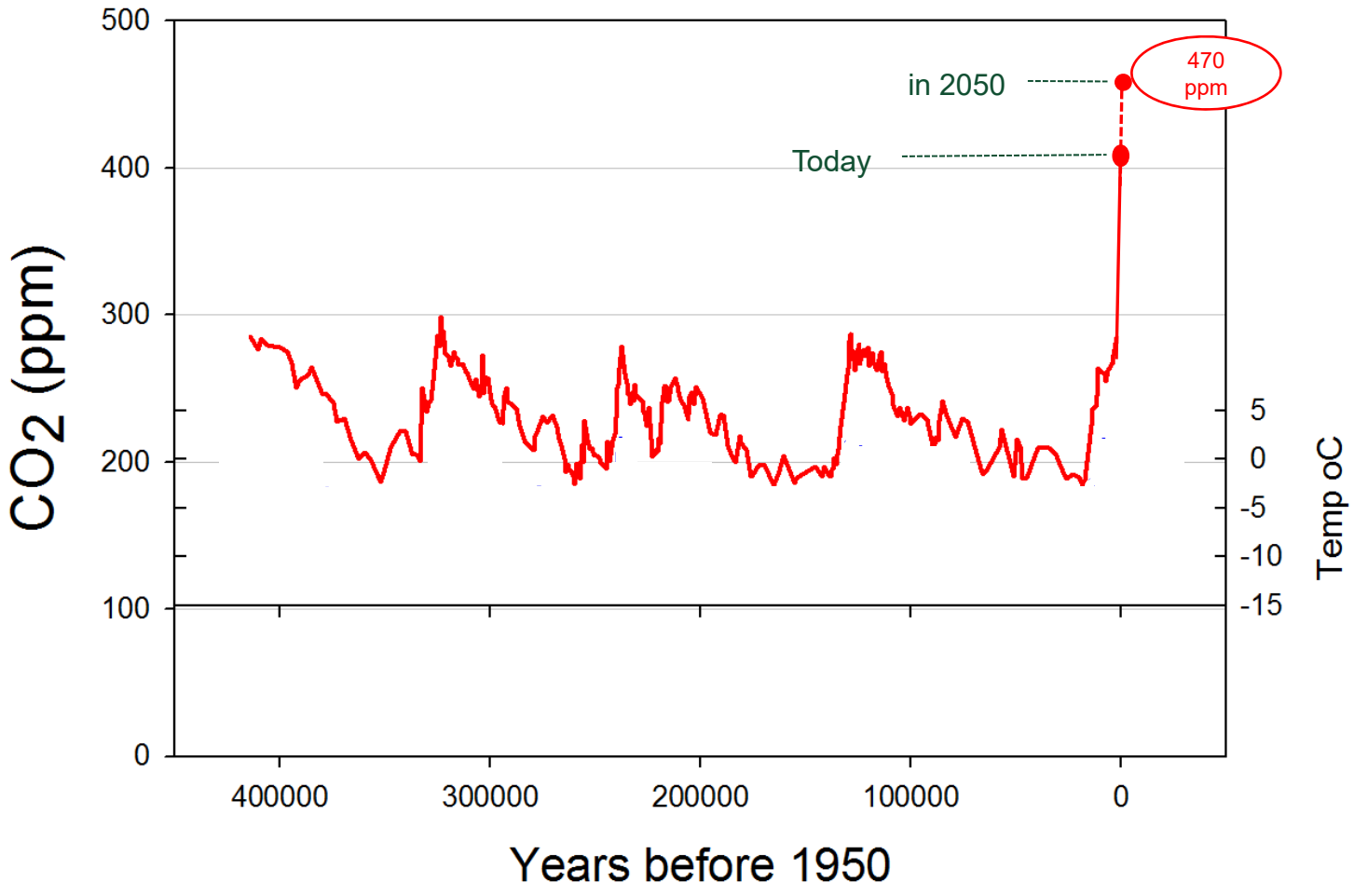
Mission: Applying Science and Engaging People to Sustain our World

Programs:

- Shorebird Recovery
- Landbird Conservation
- Sustainable Economies
- Climate Services

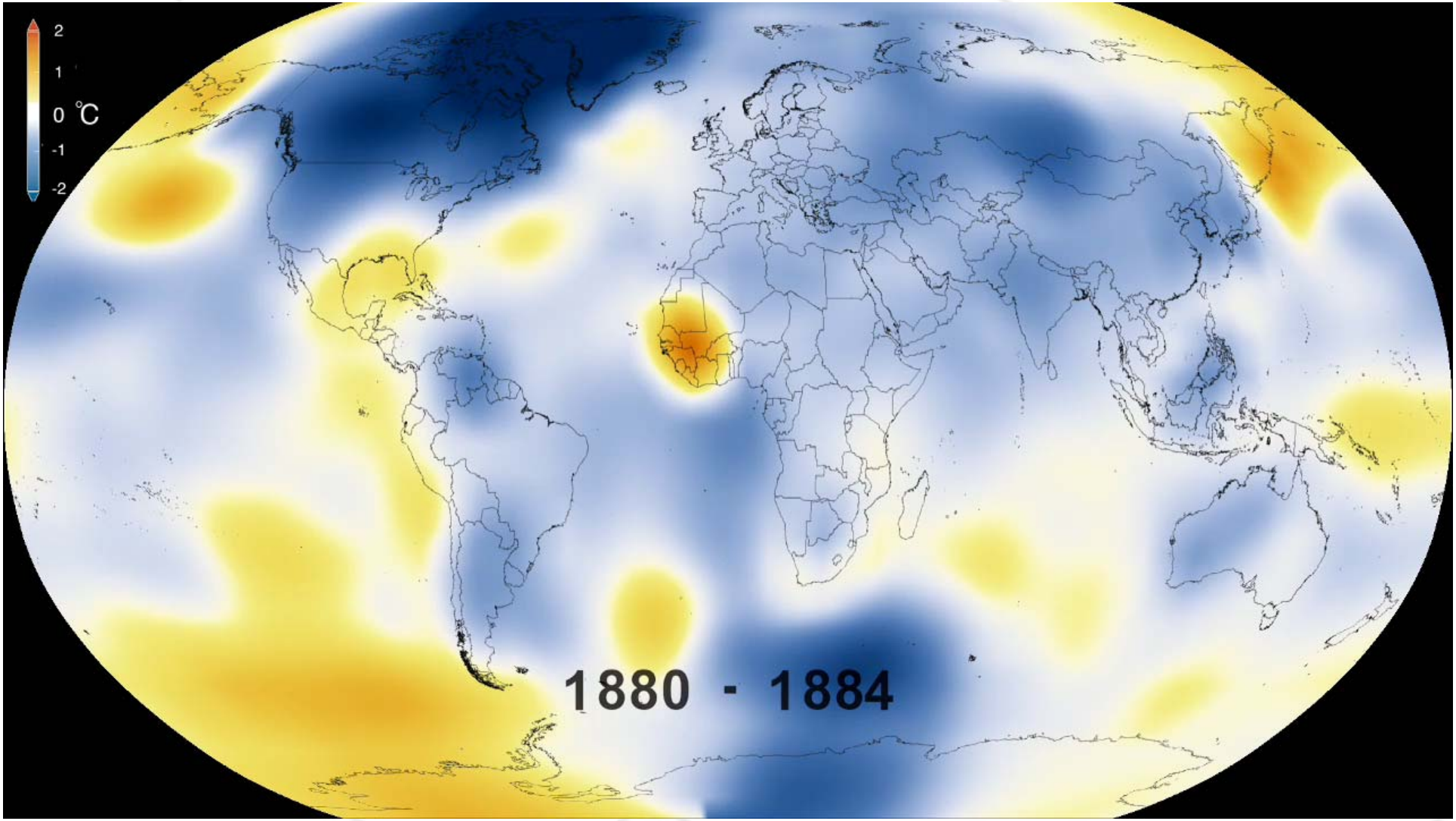
Climate Science Overview

Antarctic Ice Core Data



IPCC 2001

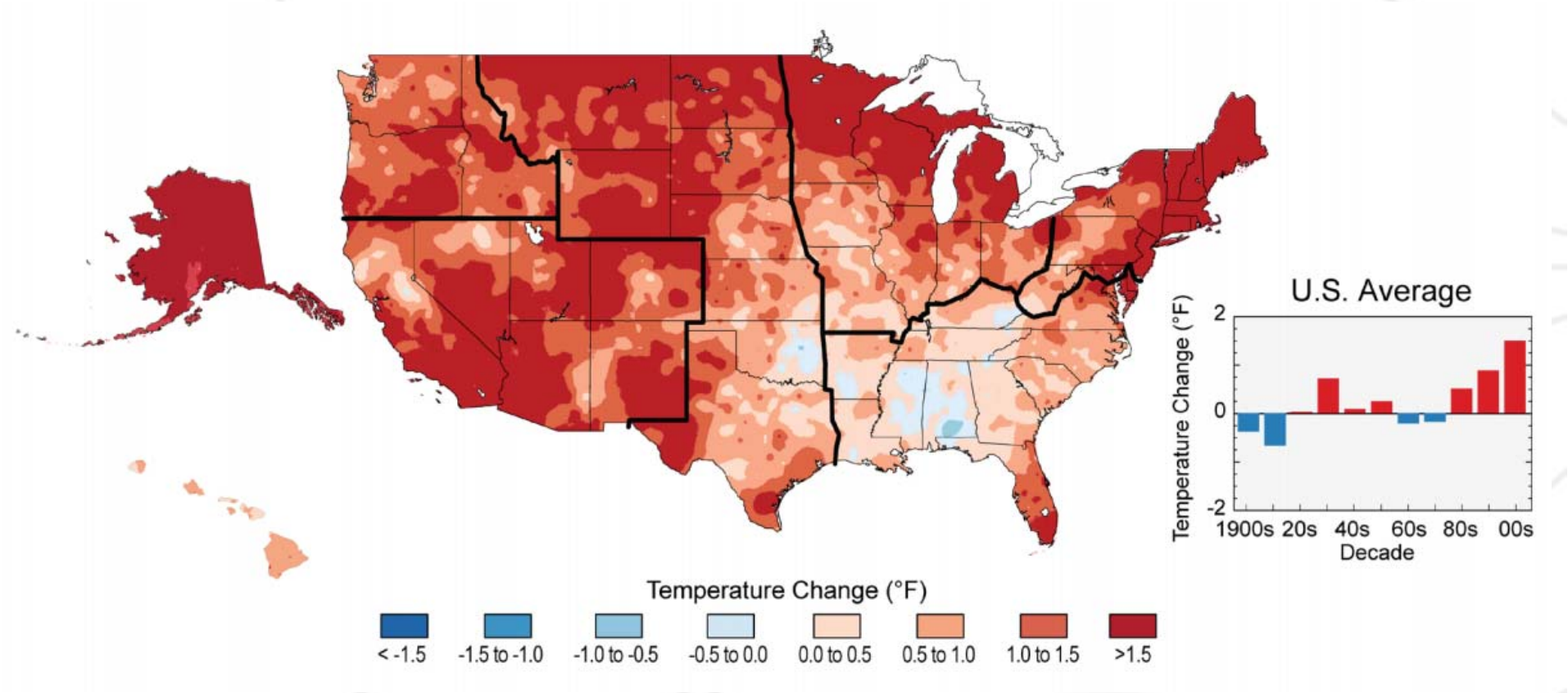
Observed Change: Temperature



Animation of Global Surface Temperature Anomalies from 1880-2015. Source: NASA/GSFC Scientific Visualization Studio

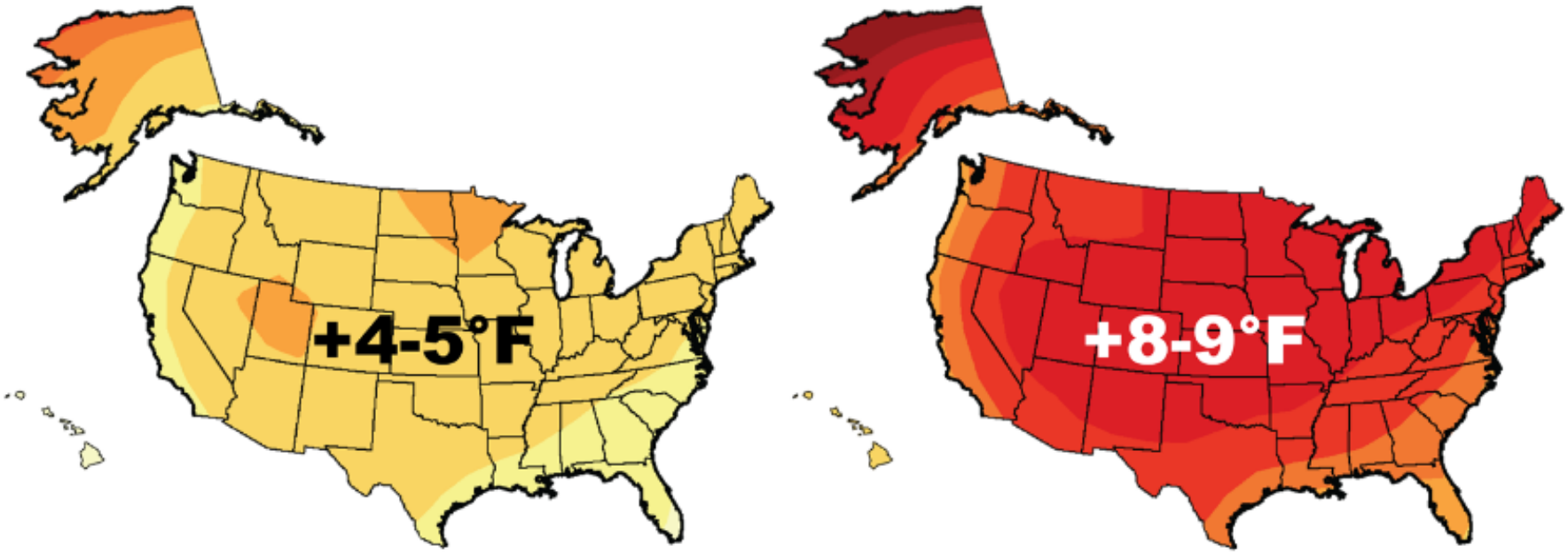
Observed Change: Temperature

U.S. Temperature Change 1991–2012
(compared to 1901 – 1960 average)



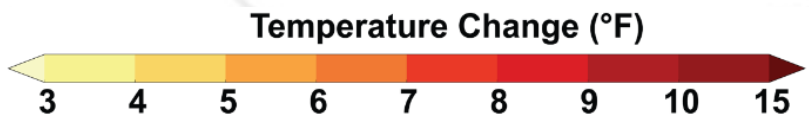
NCA 2014

Projected Change: Temperature



Lower CO_2 Emissions (B1)

Higher CO_2 Emissions (A2)

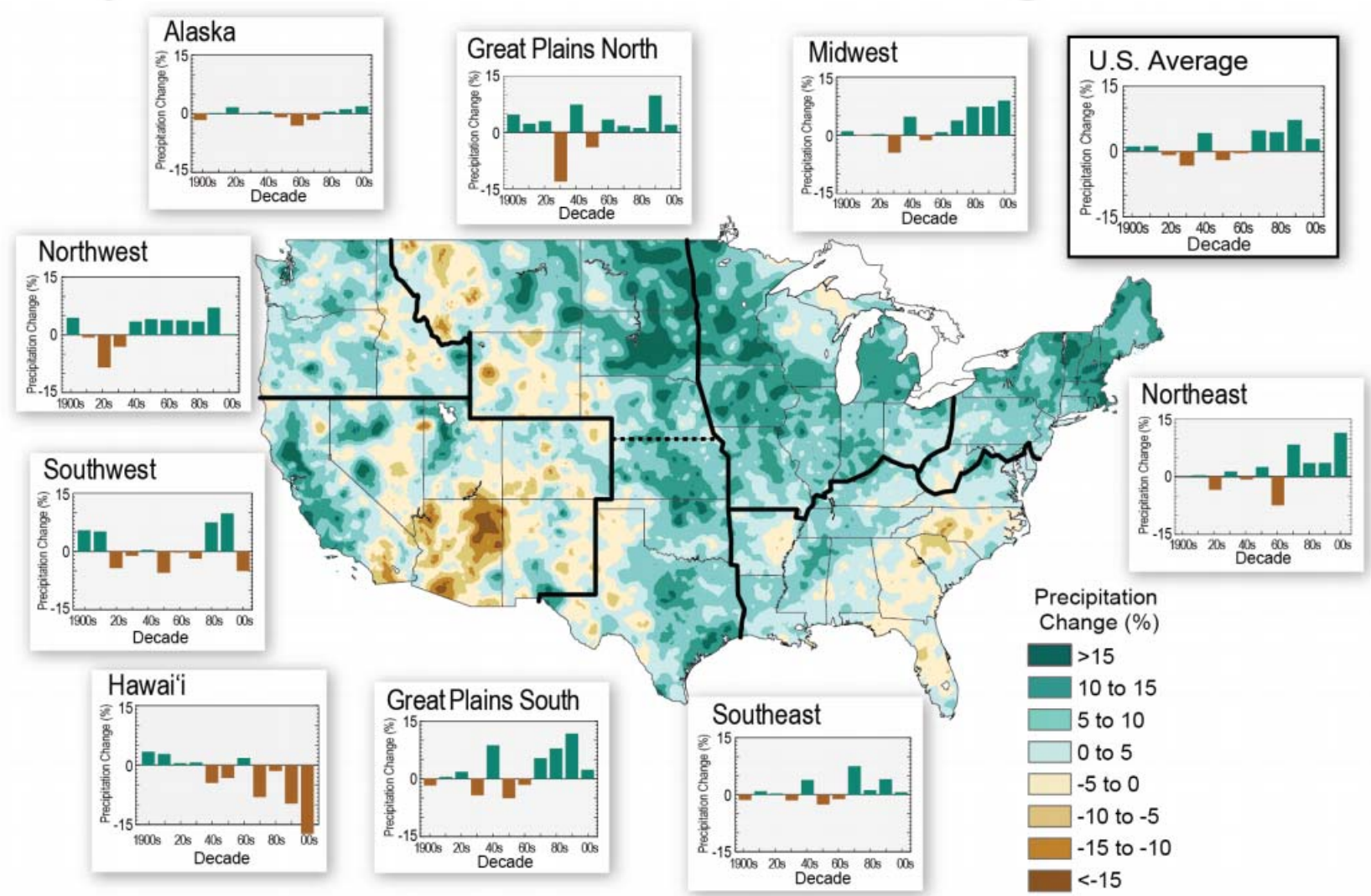


Temperature Change by 2100

NCA 2014

Projected change in average surface air temperature in the later part of this century (2071-2099) relative to the later part of the last century (1970-1999) under a scenario that assumes substantial reductions in heat trapping gases (B1, left) and a higher emissions scenario that assumes continued increases in global emissions (A2, right).

Observed Change: Precipitation

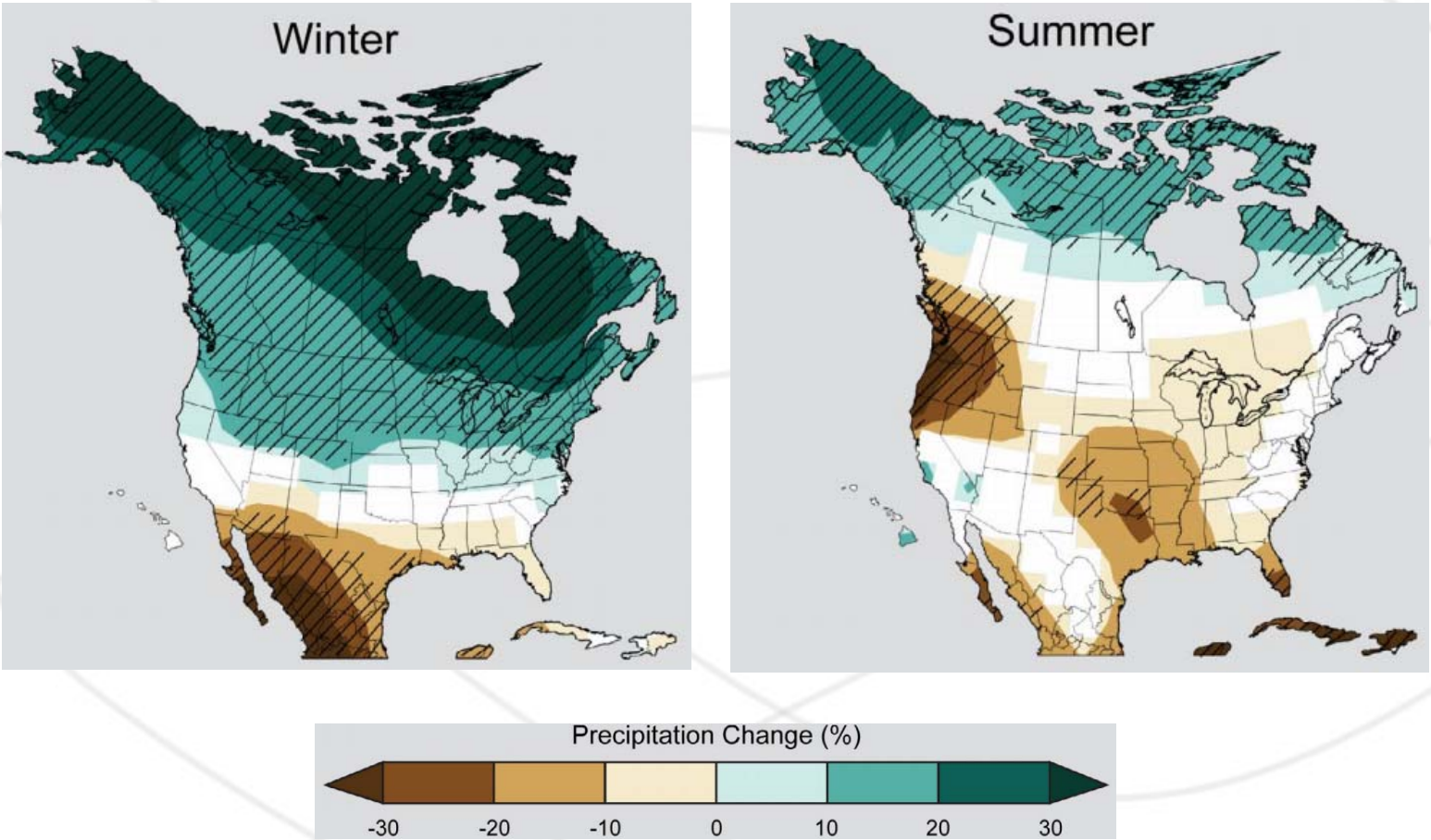


Annual total precipitation changes for 1991-2012 (compared to 1901-1960 average)

NCA 2014

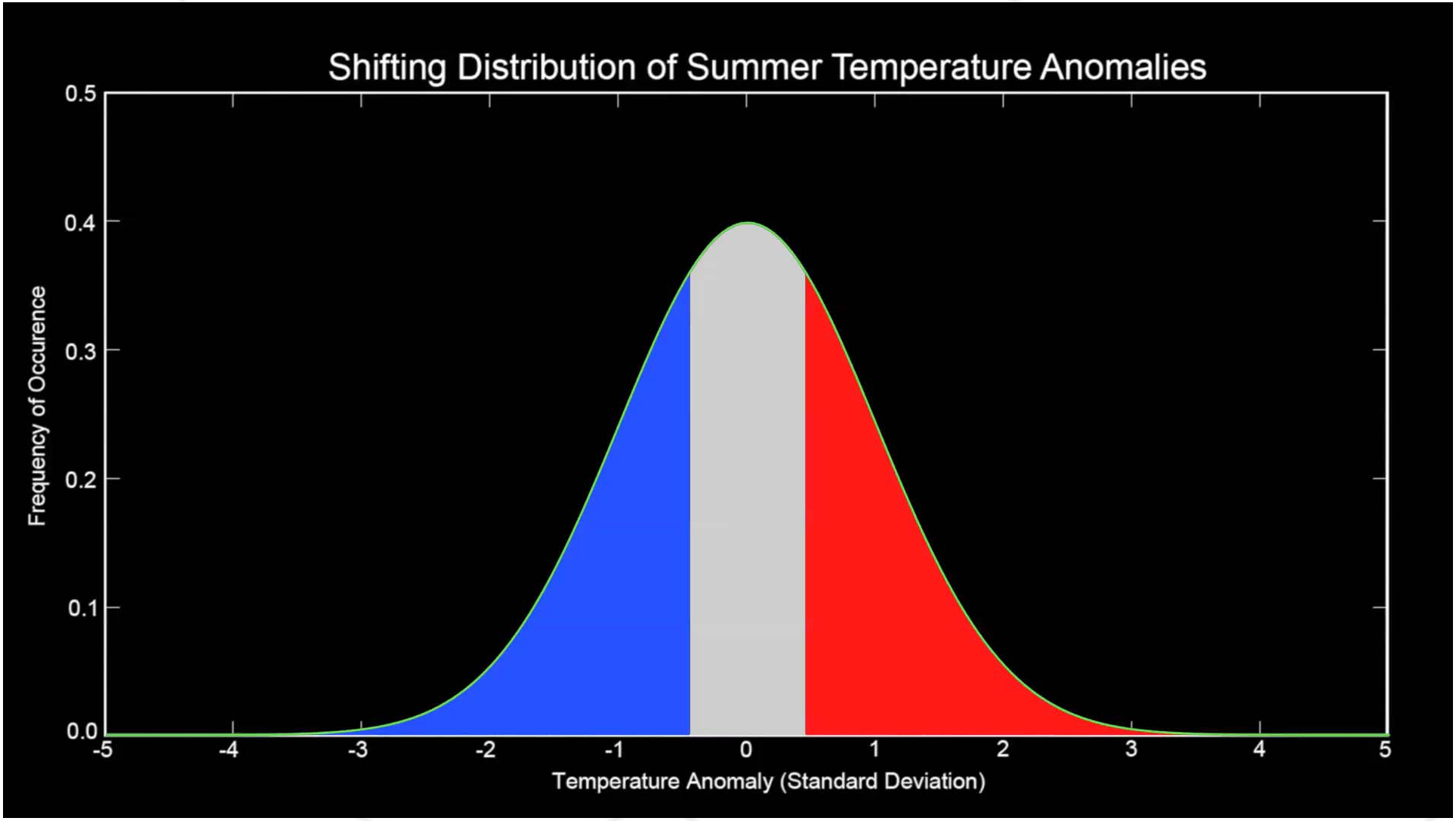
Projected Change: Precipitation

% Change in Seasonal Precipitation by end-of-century
(compared to 1970-1999) under Higher Emissions Scenario



Adapted from NCA 2013, Fig. 2.14

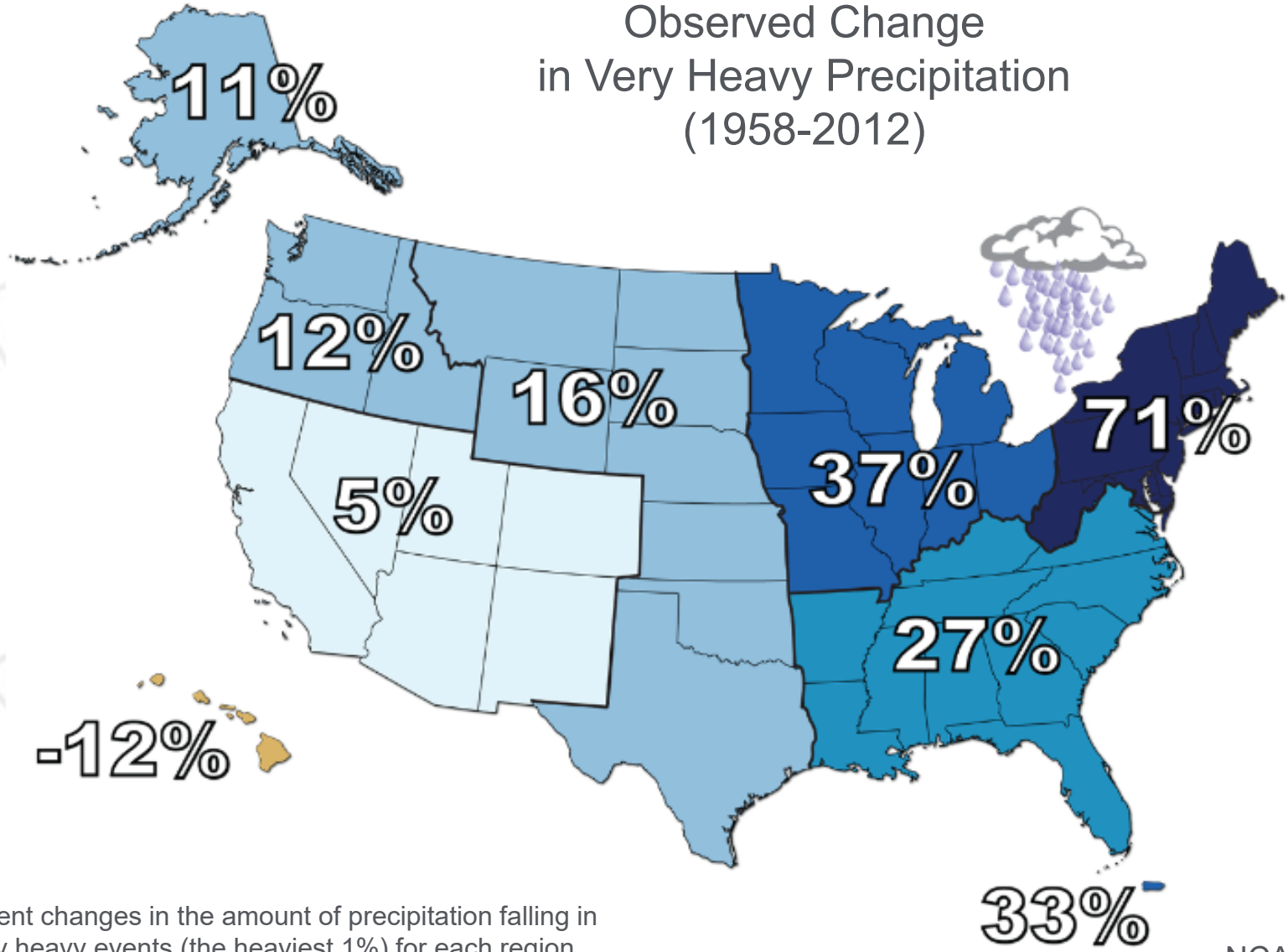
Changing Extremes: Temperature



Animation of Northern Hemisphere Summer Temperature Anomalies, compared to 1950-1980 base period.
Source: [NASA/GSFC Scientific Visualization Studio]

Changing Extremes: Precipitation

Observed Change
in Very Heavy Precipitation
(1958-2012)



Percent changes in the amount of precipitation falling in very heavy events (the heaviest 1%) for each region.

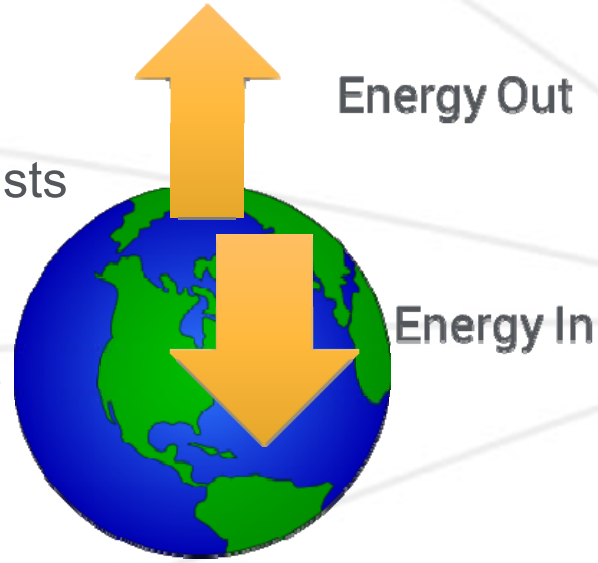
NCA 2014

Certainty & Uncertainty

What We Know and What We Don't about the Climate System

What We Know

- Greenhouse gases are warming the planet
- Other pollutants are cooling the planet
- Planet will warm while energy imbalance persists
- Regional differences in warming
  - Poles warming more rapidly than lower latitudes
- Changing precipitation patterns
  - General “wet get wetter, dry get drier” pattern
- Increasing probability of extreme heat and precipitation events
- Rising sea levels



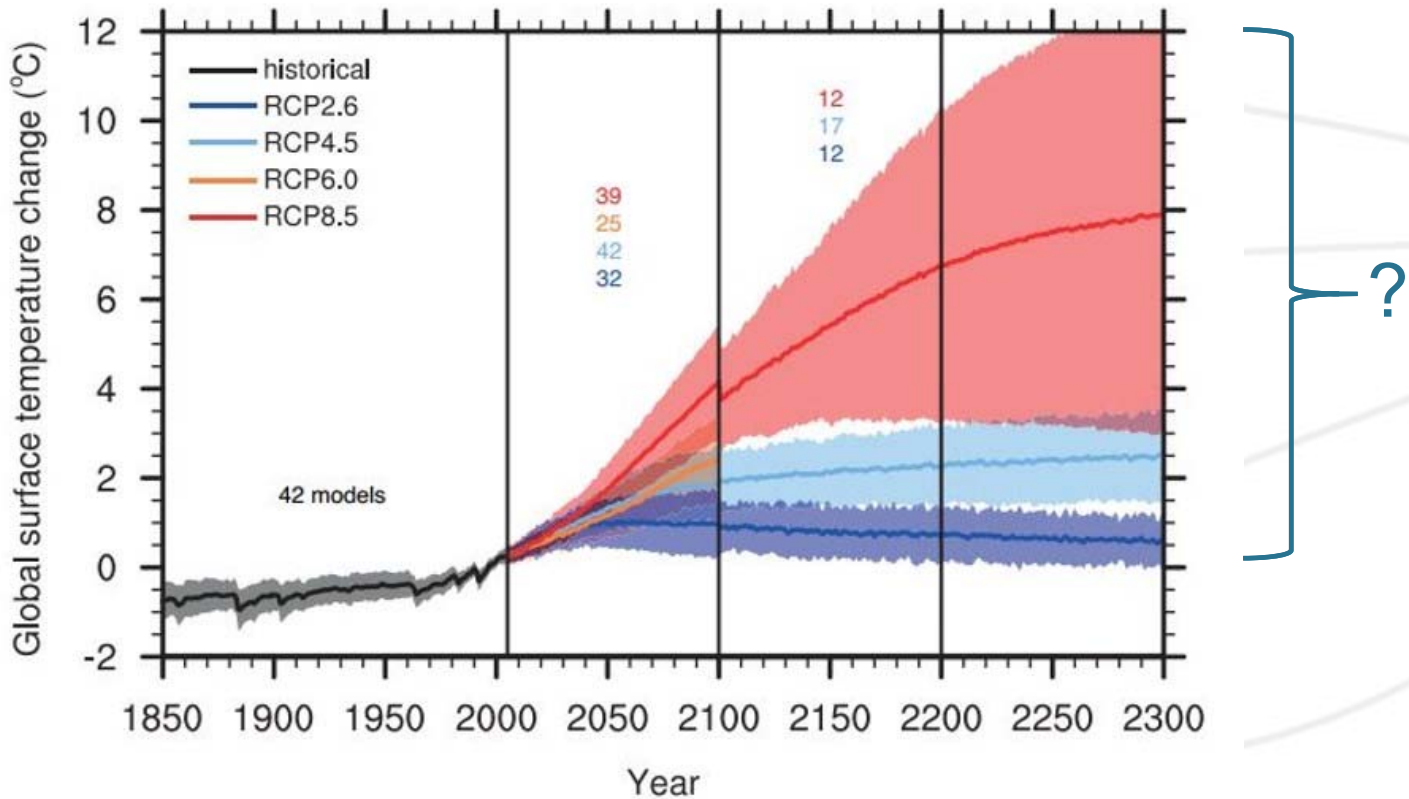
Uncertainty:
The Climate System

- **Emissions**
- **Feedbacks**
- **Tipping Points**
- **Downscaling**

Uncertainty: The Climate System

- **Emissions**
  - Future emissions depend on:

    - World population - Economic development - Energy technology



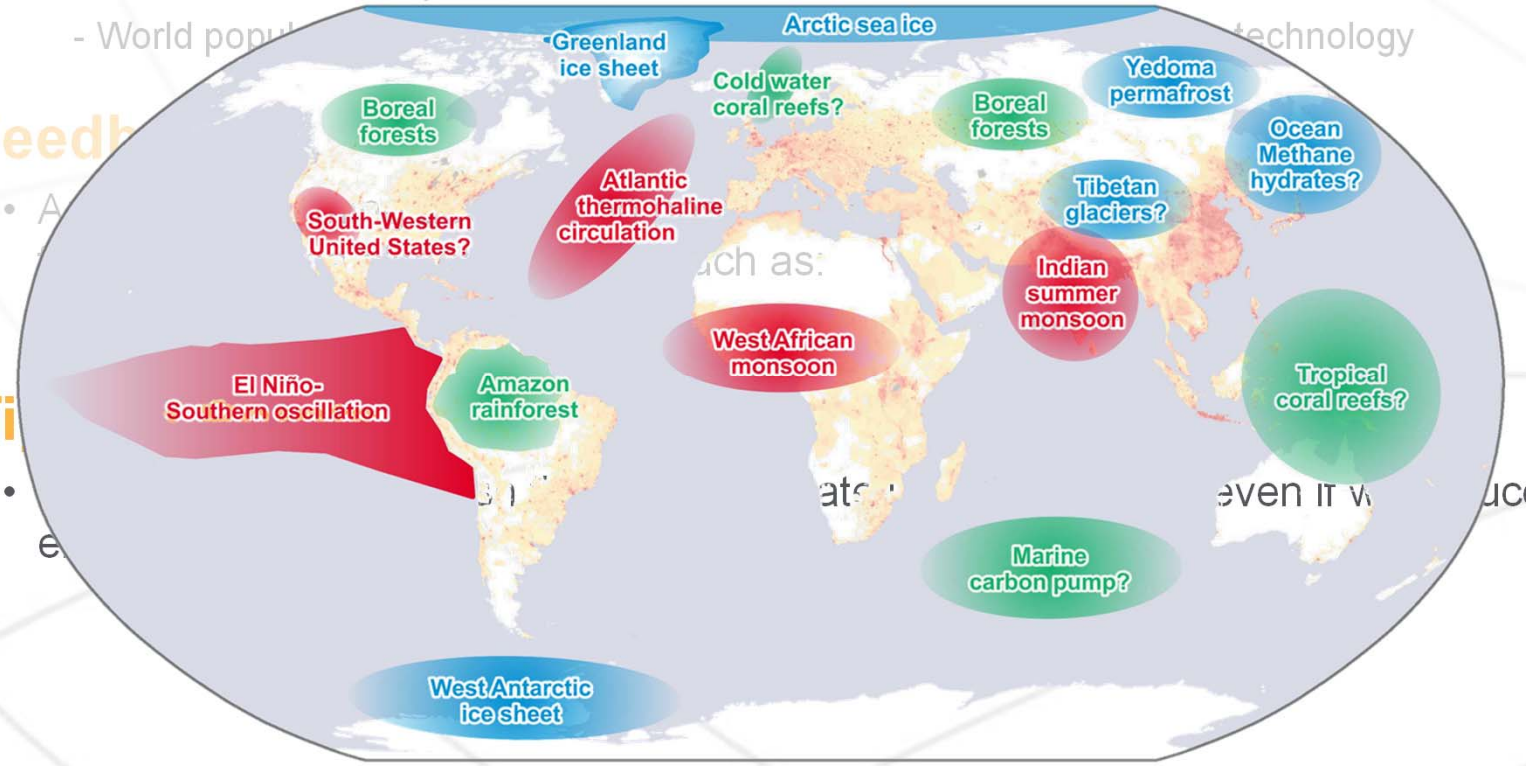
Source: IPCC AR5 WGI, Chapter 12, Fig. 12-5

Uncertainty: The Climate System

- **Emissions**
  - Future emissions depend on:
    - World population - Economic development - Energy technology
- **Feedbacks**
  - Amount of warming depends on positive (warming) and negative (cooling) feedbacks in the climate system, such as:
    - Snow-/ice albedo (+) - Water vapor (+) - Clouds (+/-) - Forests (+/-)

Uncertainty: The Climate System

- Emissions
  - Future emissions depend on:
    - World popu technology
- Feedb
  - A ch as:
- Ti
  - ats even if w uce
    e



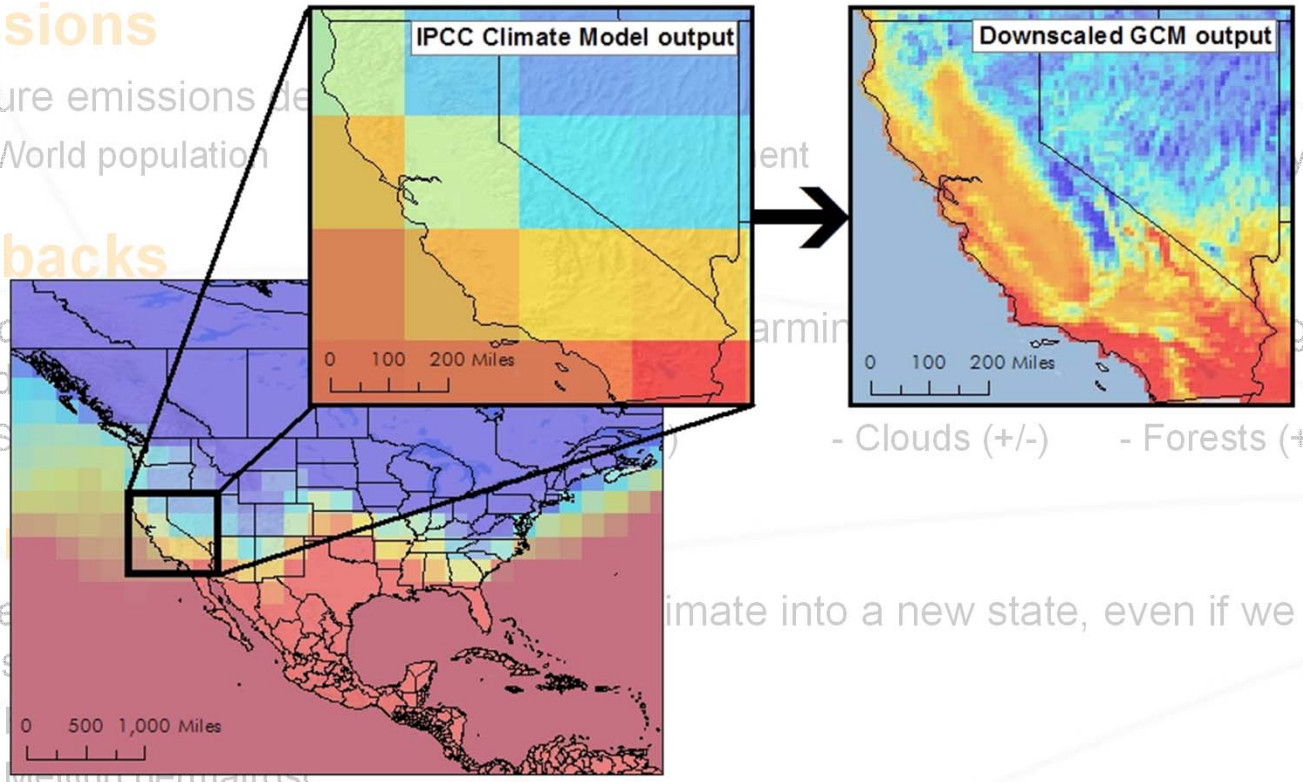
Ice Masses
Circulation Systems
Ecosystems

Population Density [persons per km²]
no data 0 5 10 20 100 200 300 400 1000

Source: [Potsdam Institute for Climate Impact Research]

Uncertainty: The Climate System

- **Emissions**
  - Future emissions de
    - World population ent
- **Feedbacks**
  - Amo armin g)
    feed
    - S - Clouds (+/-) - Forests (+/-)
- **Tippi**
  - Thre imate into a new state, even if we reduce
    emis
    -
    - Melting permafrost



Source: cal-adapt.org

- **Downscaling**
  - Extrapolating higher-resolution local or regional climate data from the results of global climate models

Climate Change and Cranberry Agriculture

Climate Change Impacts

- **Chilling Requirements**
  - **Chilling requirements will likely be met for the next 50 years**
  - **Beyond 50 years, under high emissions scenarios, chilling hours may be insufficient**

Climate Change Impacts

- **Frost Damage**
  - **Abnormally warm periods in late winter and early spring increase window when frost damage can occur**

Climate Change Impacts

- **Scald**
  - **Heat stress injury that occurs when plants can't transpire quickly enough to keep fruit cool**
  - **Primary adaptive response is to insure sufficient soil moisture prior to onset of heat stress conditions**

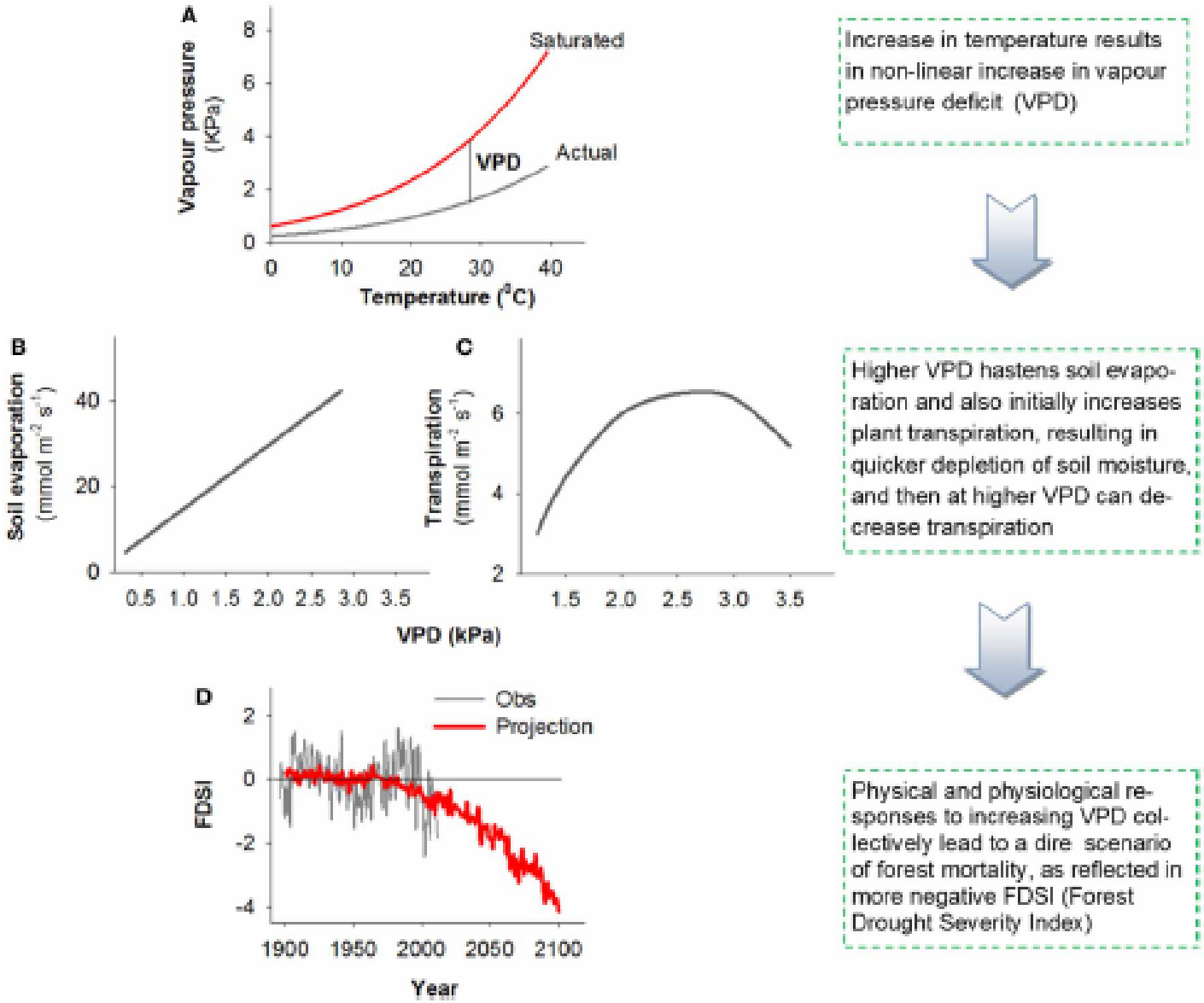


FIGURE 1 | A conceptual figure illustrating the effect of increased VPD on the biophysical factors that influence tree physiology, drought stress, and survival. Higher temperatures increase VPD non-linearly (**A**), higher VPD will generally both deplete soil moisture (**B**) and increase plant stress though changes in transpiration (**C**; based on data from Eamus et al. (2008)), all of which are projected to contribute to non-linear increases in forest stress (highlighted by the Forest Drought Severity Index (FDSI), with more negative values corresponding to increased stress) and resultant widespread regional mortality (**D**; Williams et al., 2013).

Climate Change Impacts

- **Changing Precipitation Patterns**
  - **Increasing annual precipitation but with important seasonal differences**
  - **Continued biasing towards heavy precipitation events**

Climate Change Impacts

- **Rot**
  - **Increasing stress associated with scald and changing precipitation patterns may increase vulnerability to fungal damage**

Likely Climate Change Impacts

- **Changing Insect Pressure**
  - **Insect ranges are expanding northward as average temperatures warm**

Climate Change Opportunity

- **Productivity**
  - **Carbon rich atmosphere and longer growing season can enhance growth if other stressors can be successfully managed**

Resources from the CSLN

http://climatesmartnetwork.org/bulletins/

- **Storm Water & Stream Crossings**
- **Climate Change, Wind, & Forest Mgmt**
- **Ecologically-Relevant Changes in Temperature Variability**
- **Global Temperature** *Observed Trends; Projections*
- **Global Precipitation** *Trends & Projections; Ecosystem & Mgmt Implications*
- **Certainty & Uncertainty** *The Climate System; The Forest Response*
- **Forest Pests & Climate Change**
- **El Niño Update & Implications for Forestry**
- **Climate Change & Extreme Weather** *Trends & Projections; Forest Impacts*
- **Wildlife & Biodiversity Impacts** *Overview; Examples*
- **Modeling Future Forests**
- **Carbon Markets & Forests: What Does the Future Hold?**
- **Climate Change & Forest Productivity**
- **Wildfire in a Warming World**

Stay Alert and Keep Learning

Thank You

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