What does climate change mean for NY agriculture?

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2020 Agricultural and Food Business Outlook Conference
January 17, 2020, Ithaca, NY

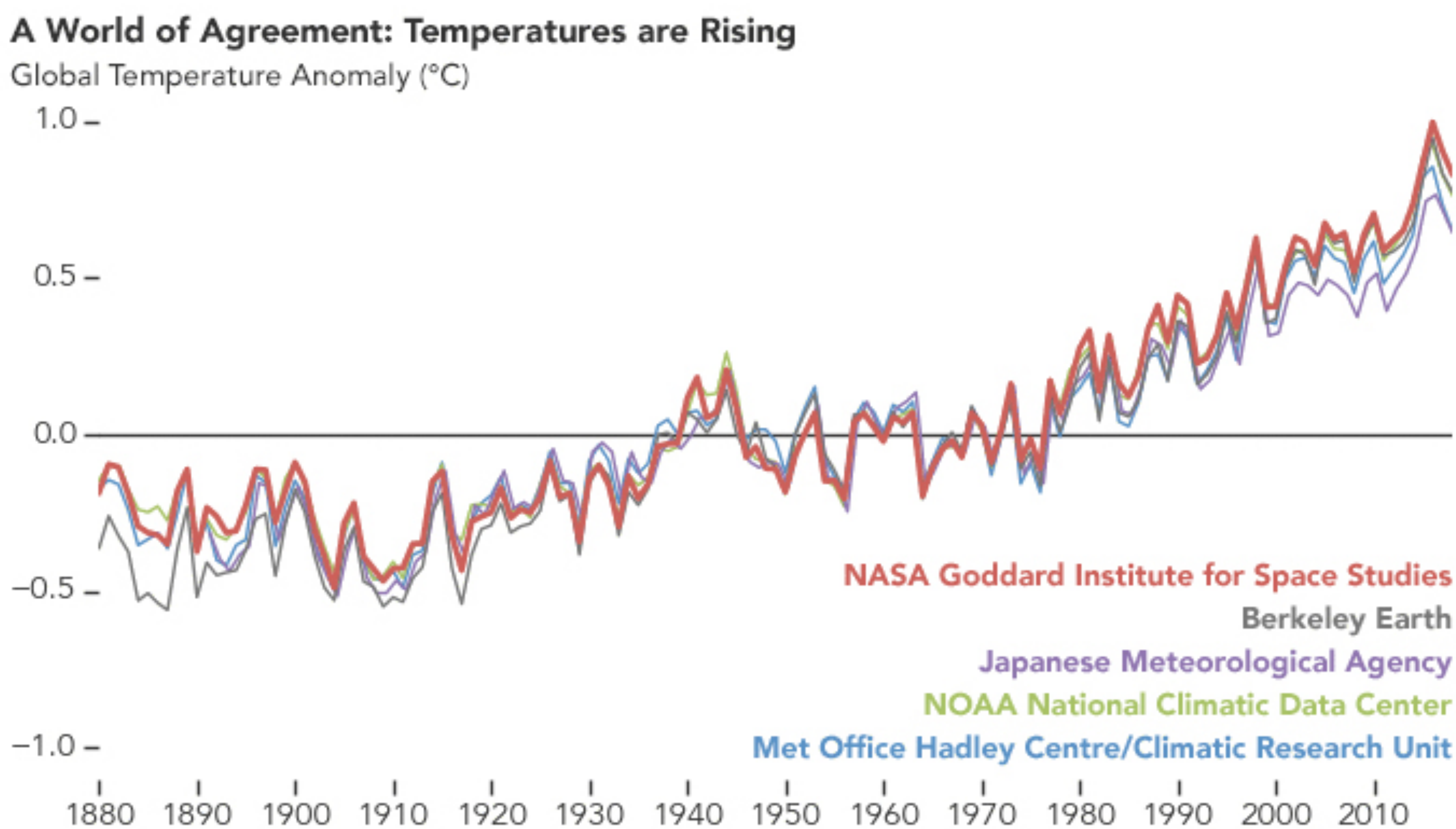
1. Presentation

A bit about me

- Assistant Professor, Charles H. Dyson School of Applied Economics and Management (since 2014)
- Teaching 50% / Research 50%
- Research: Impacts of extreme weather and climate change on agriculture
- Increasingly working on other climate-related topics: migration, nutrition, trade, land use change, finance, etc.
- But main focus remains agriculture (US and beyond)

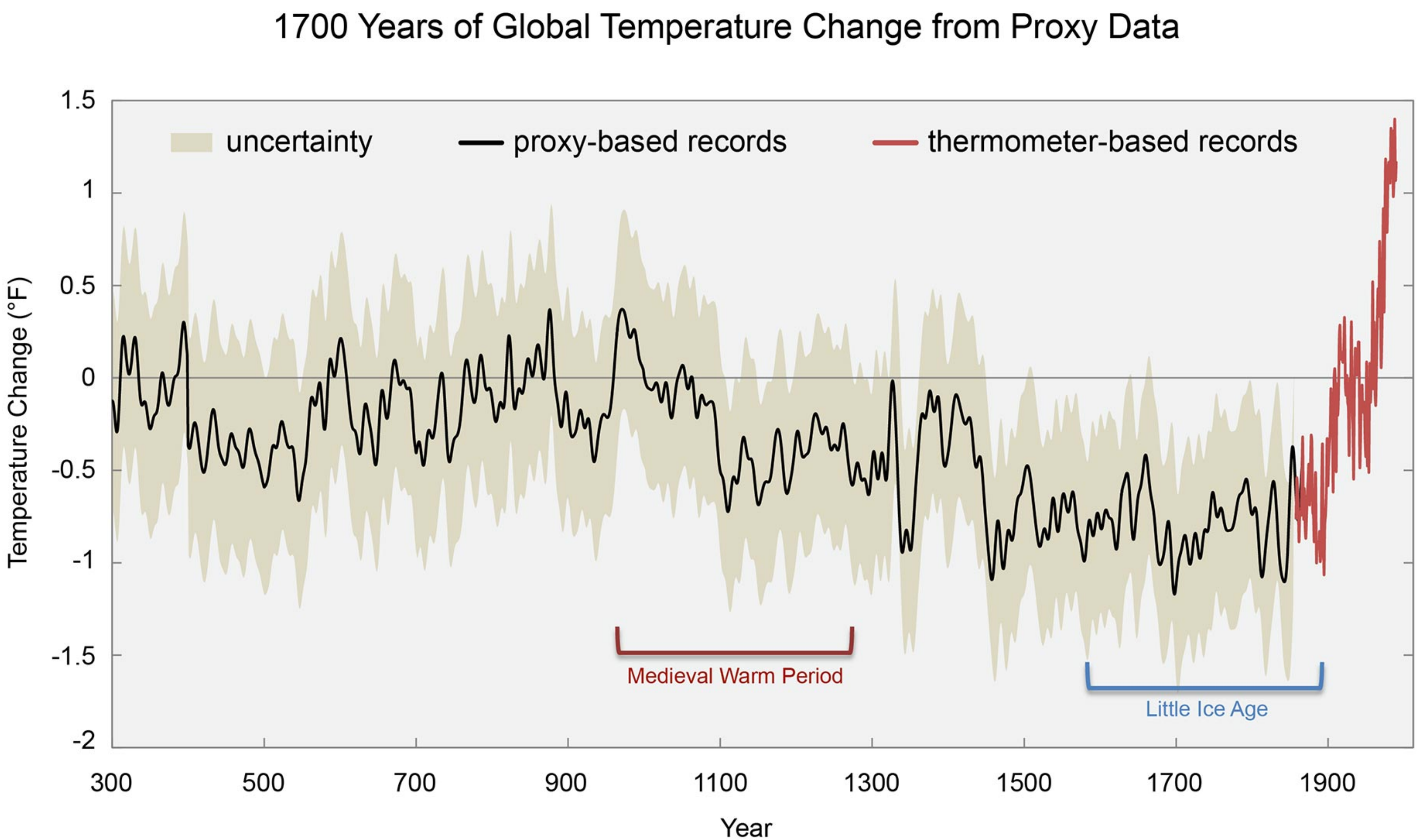
2. The science

Earth's climate is warming

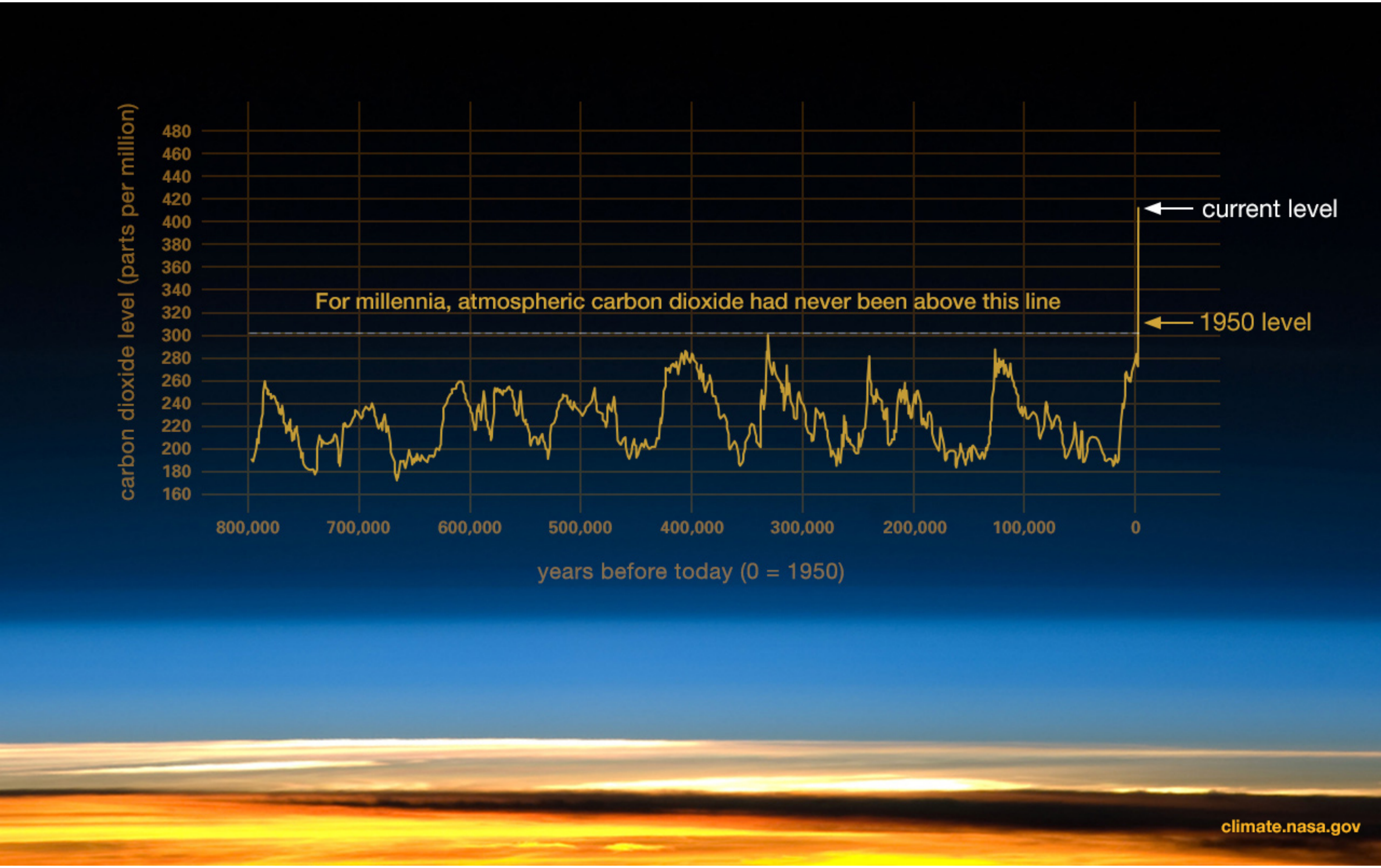


Temperature data showing rapid warming in the past few decades, the latest data going up to 2018. According to NASA data, 2016 was the warmest year since 1880, continuing a long-term trend of rising global temperatures. The 10 warmest years in the 139-year record all have occurred since 2005, with the five warmest years being the five most recent years. Credit: NASA's Earth Observatory.

Source: https://climate.nasa.gov/scientific-consensus/

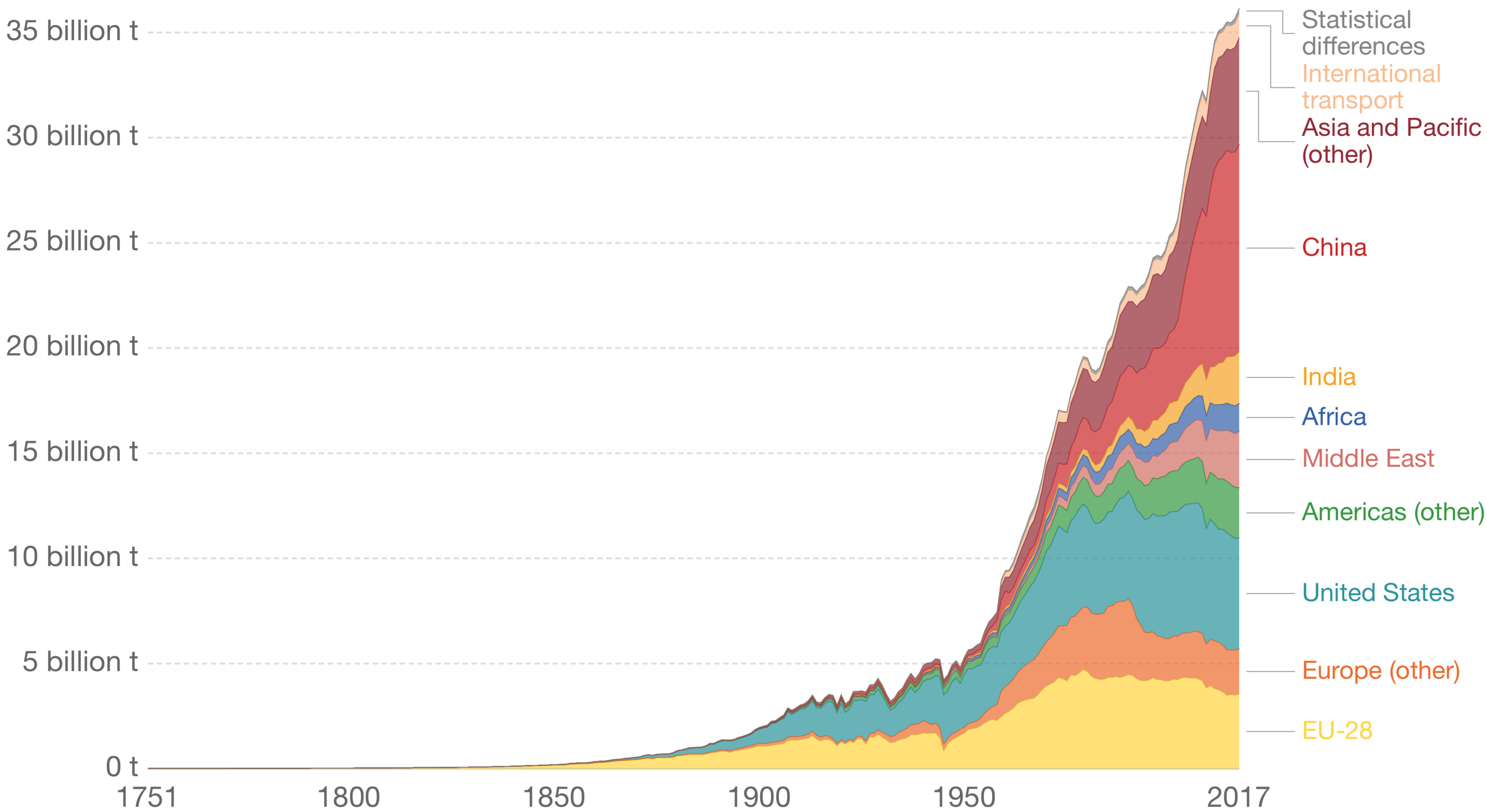


Source: https://nca2014.globalchange.gov/report/appendices/faqs/graphics/1700-years-temperature-change-proxy-data



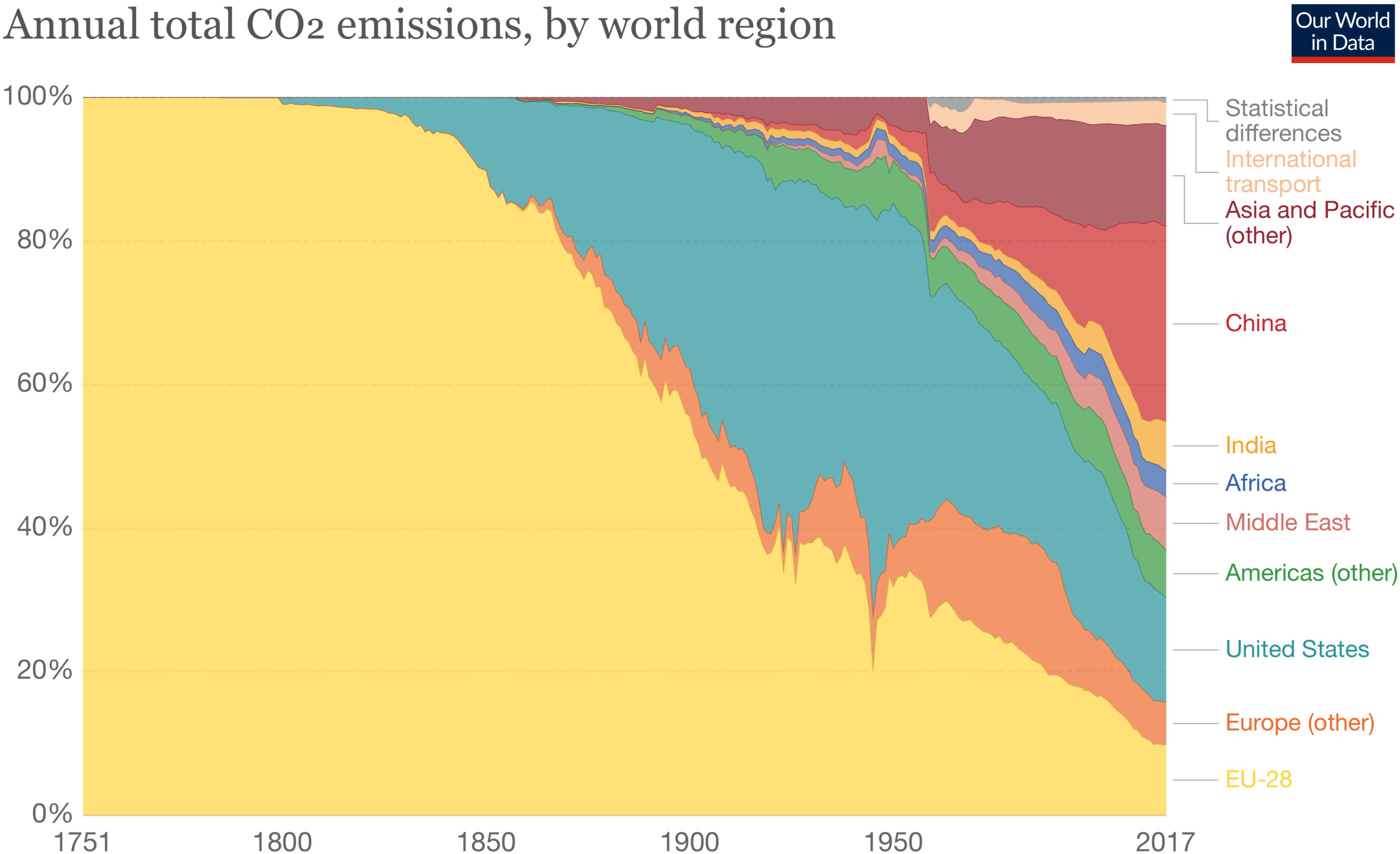
Source: https://climate.nasa.gov/evidence/

Annual total CO_2 emissions, by world region



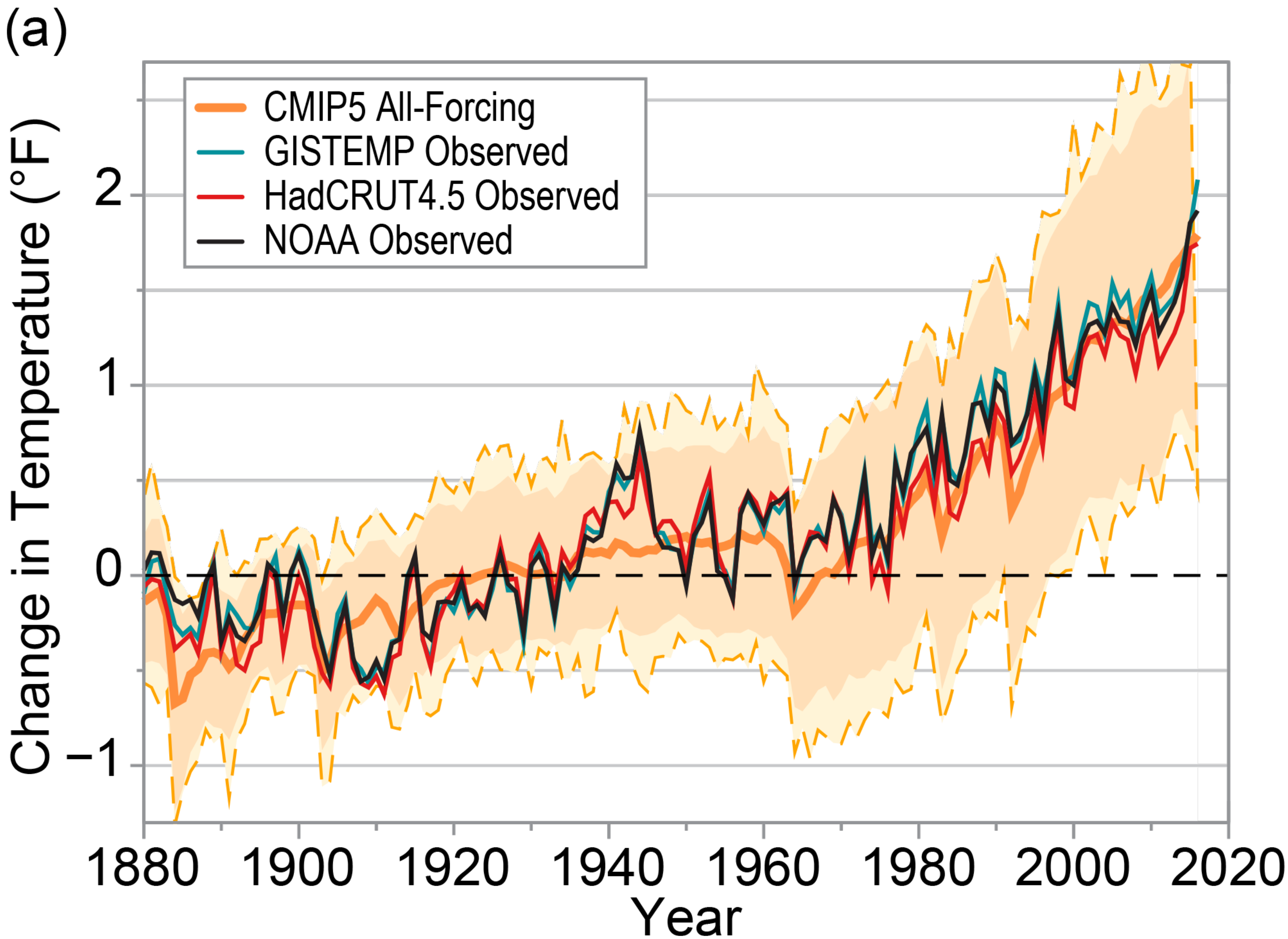
Source: Carbon Dioxide Information Analysis Center (CDIAC); Global Carbon Project (GCP)
Note: "Statistical differences" notes the discrepancy between estimated global emissions and the sum of all national and international transport emissions.

Annual total CO_2 emissions, by world region

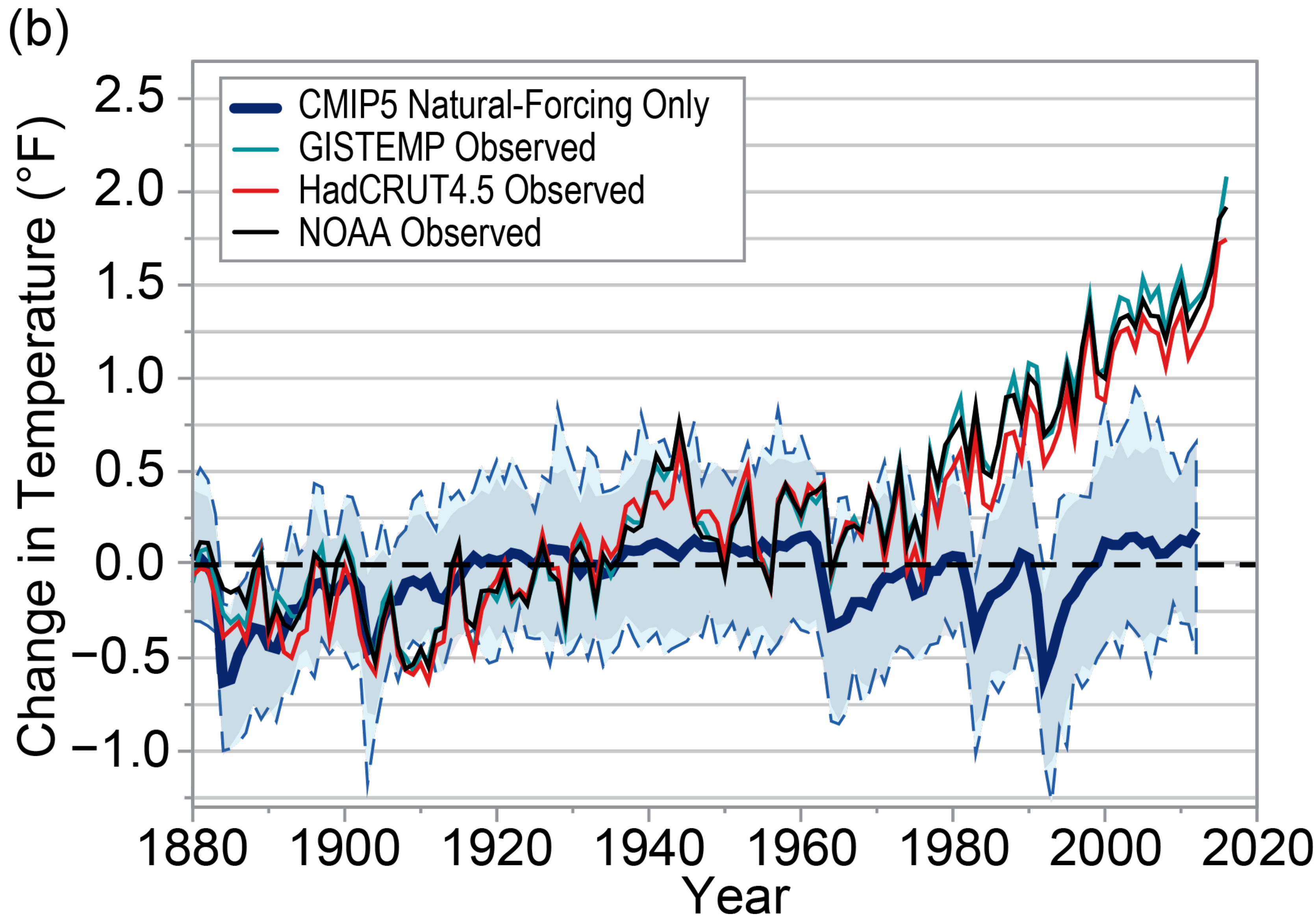


Source: Carbon Dioxide Information Analysis Center (CDIAC); Global Carbon Project (GCP)
Note: "Statistical differences" notes the discrepancy between estimated global emissions and the sum of all national and international transport emissions.

Climate models replicate the observed global warming

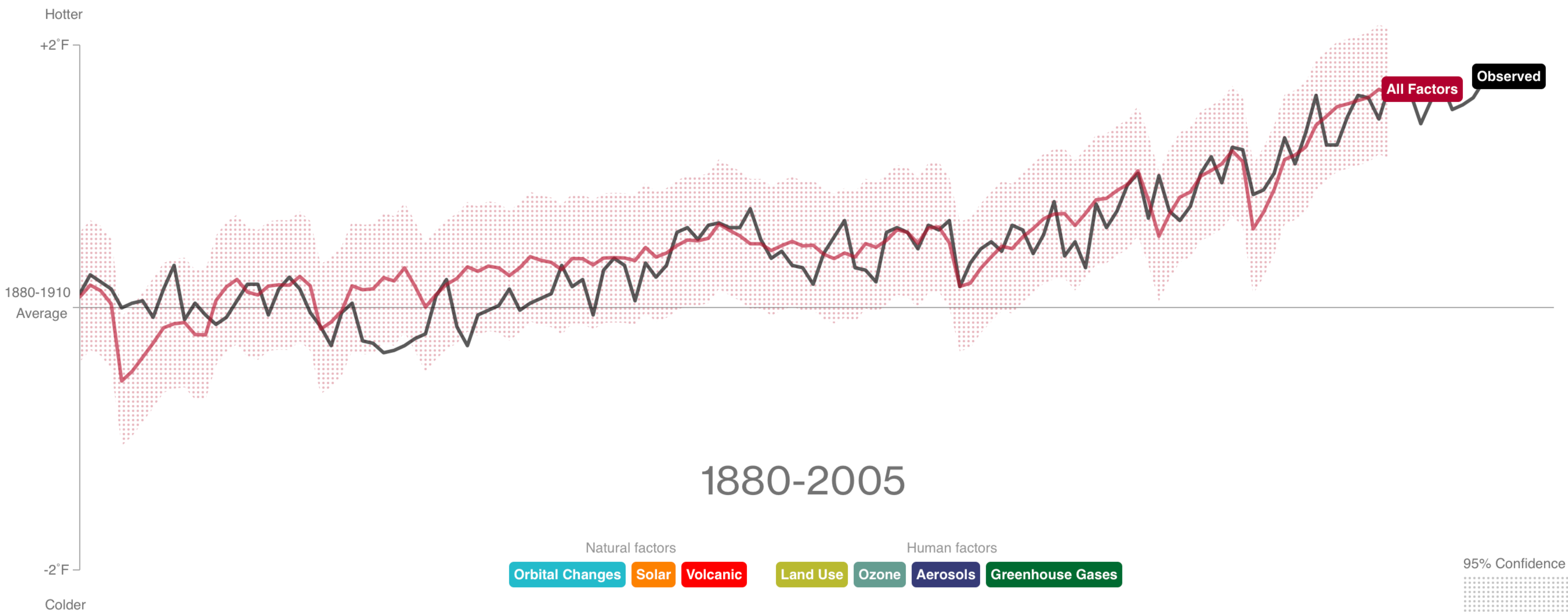


Natural causes alone CANNOT replicate the observed global warming



Compare and Contrast

Putting the possible natural and human causes of climate change alongside one another makes the dominant role of greenhouse gases even more plainly visible. The only real question is: What are we going to do about it?

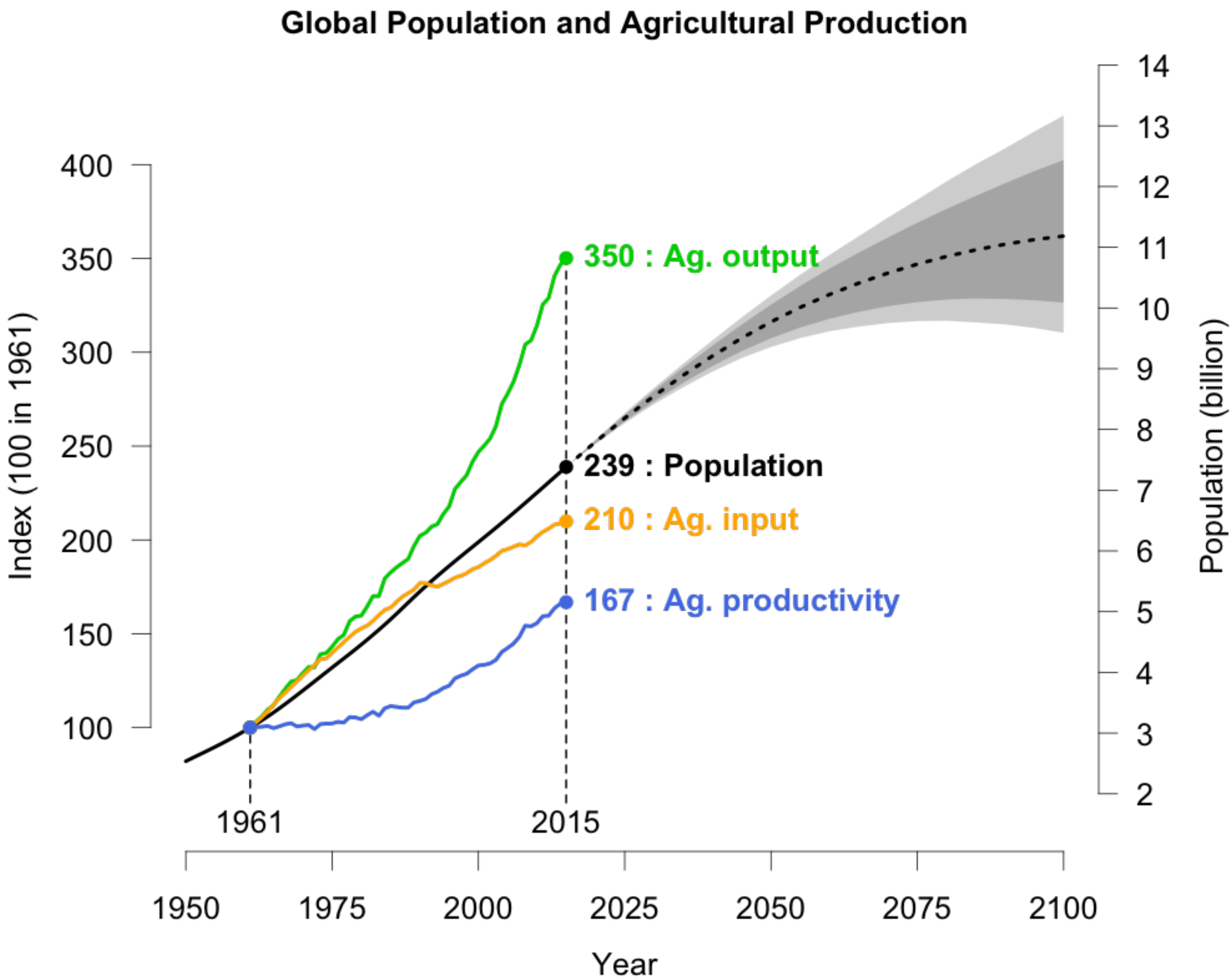


Source: Bloomberg

Overwhelming scientific consensus

- American scientific societies
  - e.g. : American Association for the Advancement of Science (AAAS), America Chemical Society (ACS), American Geophyisical Union (AGU), American Meteorological Society (AMS), American Physical Society (APS), etc.
- US National Academy of Sciences
- US government agencies
  - e.g. US Global Change Research Program, etc.
- International bodies
  - Intergovernmental Panel on Climate Change (IPCC)

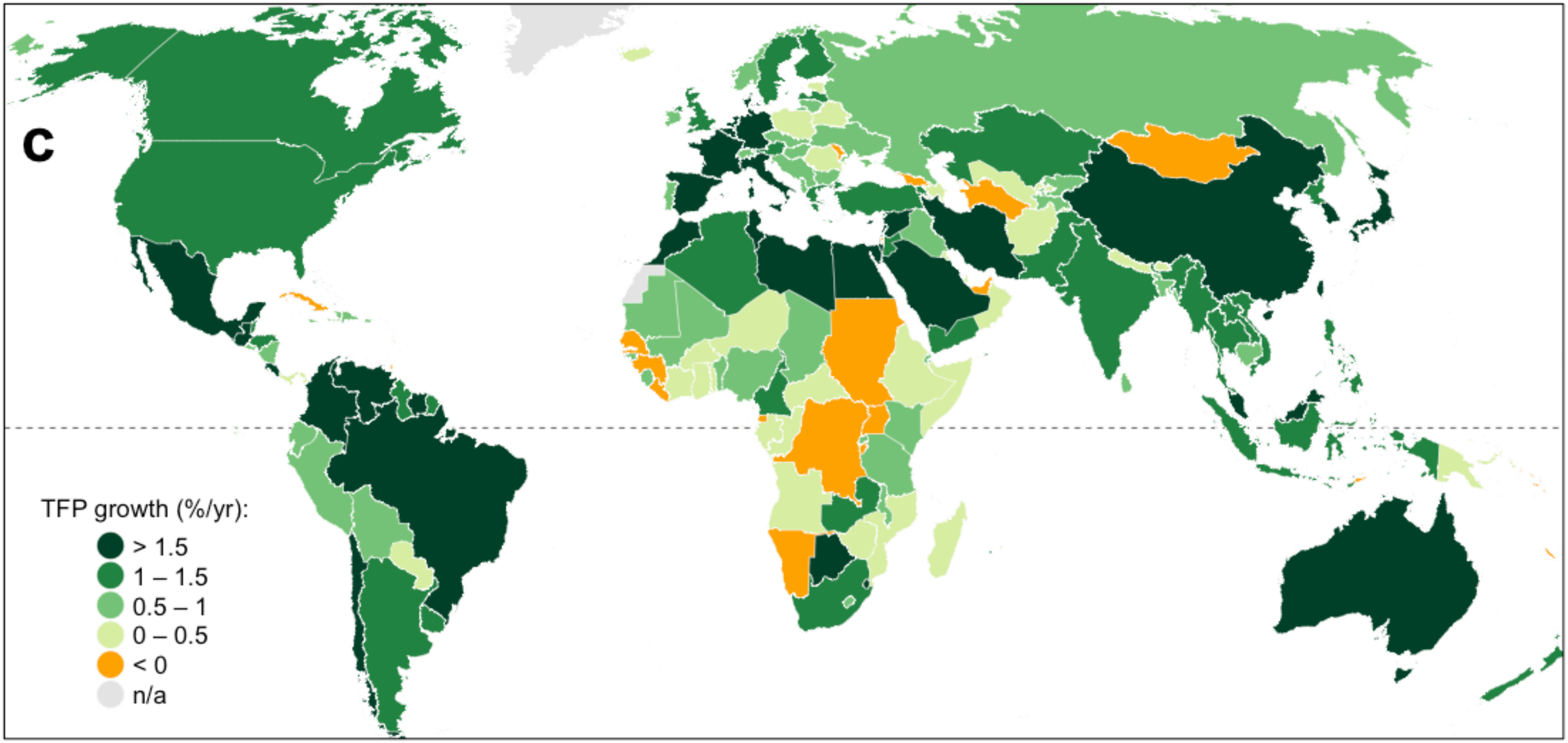
3. The challenge



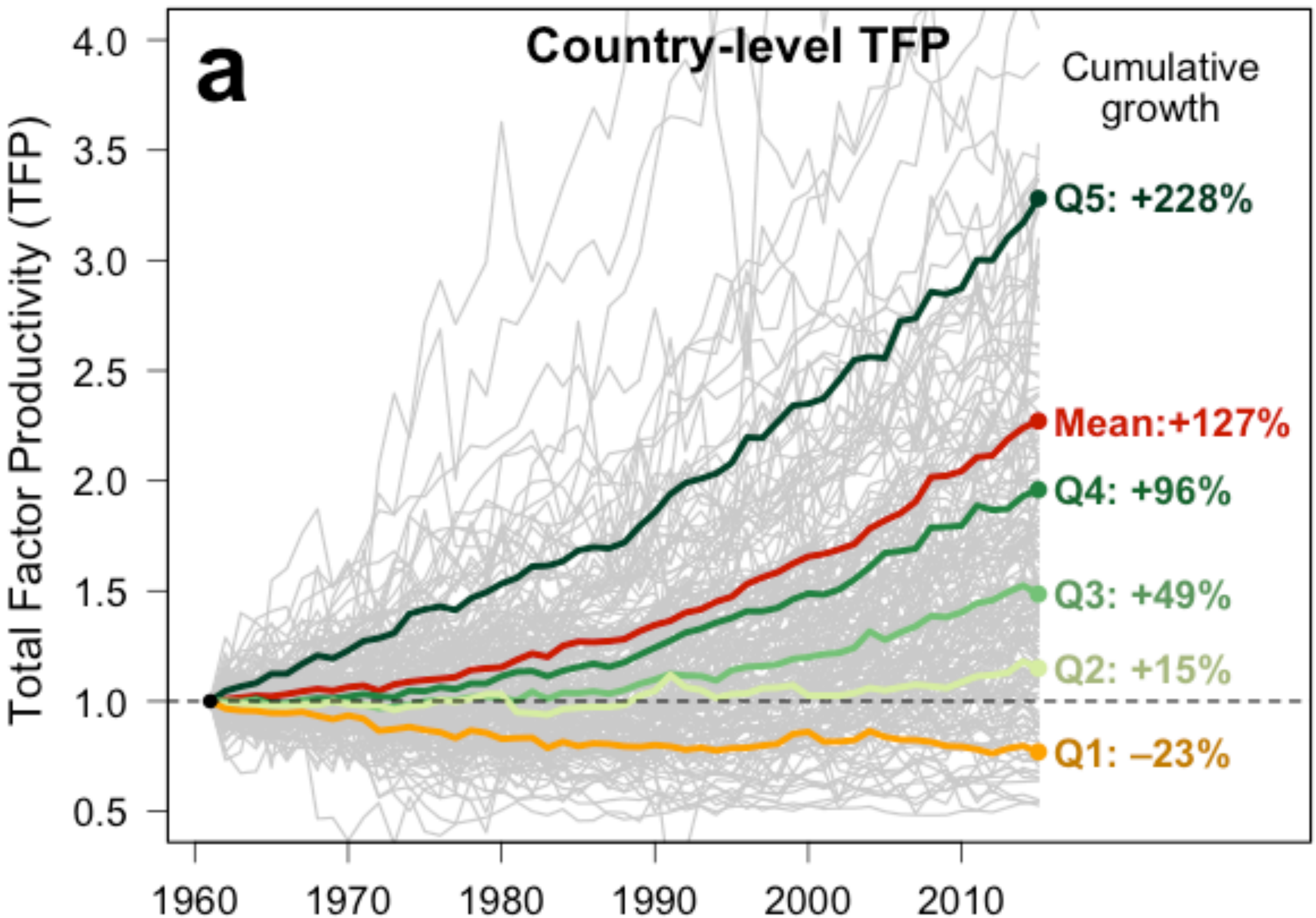
Global Population and Agricultural Production
350 : Ag. output
239 : Population
210 : Ag. input
167 : Ag. productivity
Index (100 in 1961)
400
350
300
250
200
150
100
Population (billion)
14
13
12
11
10
9
8
7
6
5
4
3
2
1961
2015
1950
1975
2000
2025
2050
2075
2100
Year

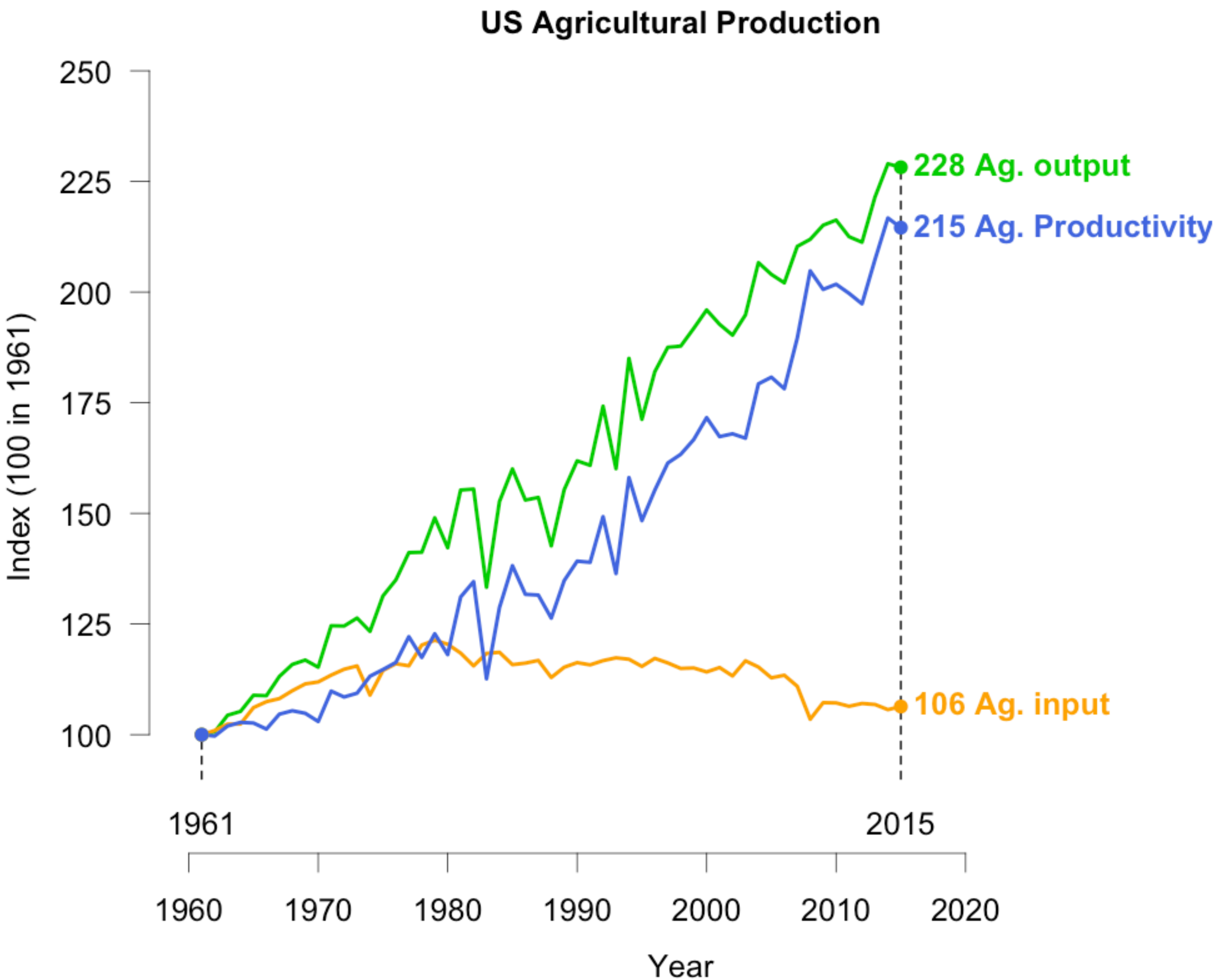
Agricultural TFP growth

(1961-2015)

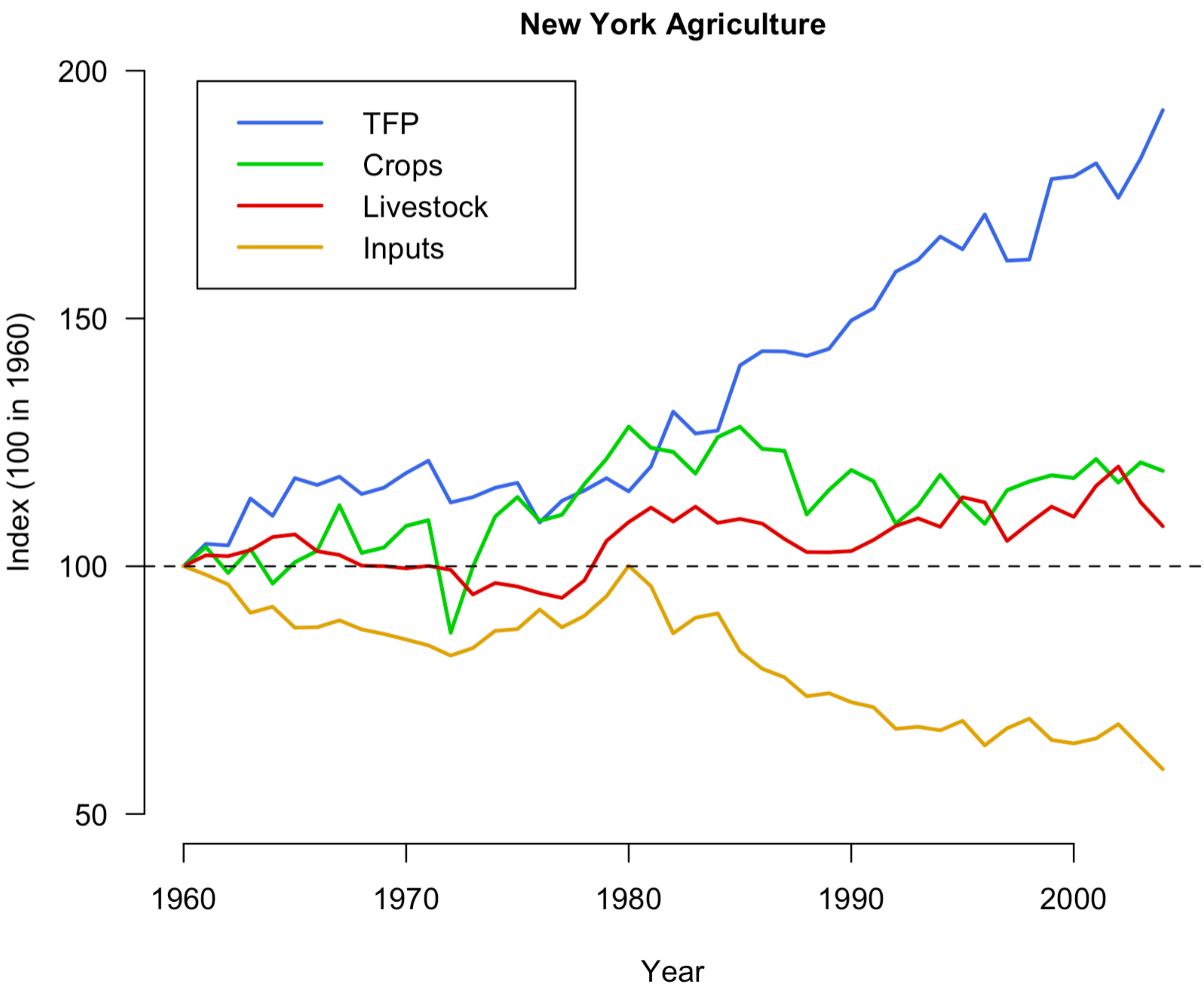


Agricultural TFP growth
(1961-2015)



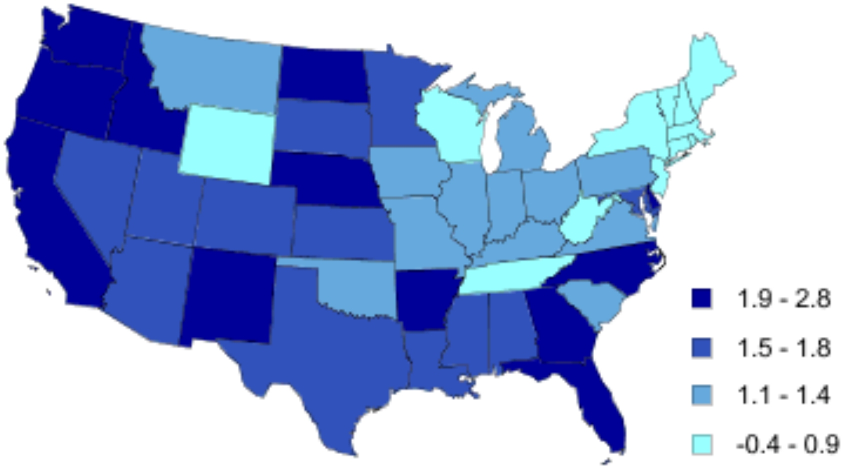


US Agricultural Production
250
225
200
175
150
125
100
Index (100 in 1961)
228 Ag. output
215 Ag. Productivity
106 Ag. input
1961
2015
1960
1970
1980
1990
2000
2010
2020
Year


New York Agriculture
TFP
Crops
Livestock
Inputs
200
150
100
50
Index (100 in 1960)
1960
1970
1980
1990
2000
Year

Change in agricultural output by State, 1960-2004

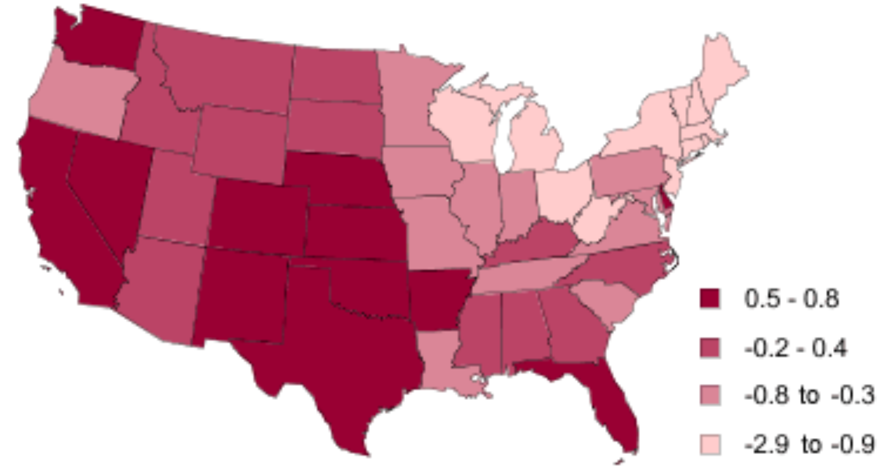
Average annual change (percent)



Source: ERS data product, Agricultural Productivity in the United States.
Average annual growth for the U.S. was 1.67 percent for the period 1960-2004.

Change in agricultural input use by State, 1960-2004

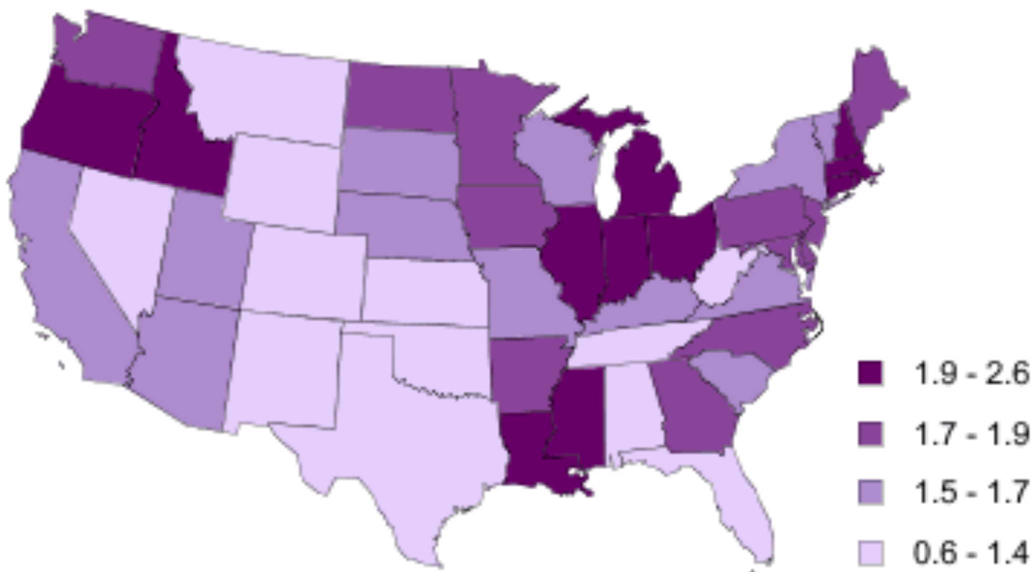
Average annual change (percent)



Source: USDA, Economic Research Service, *Agricultural Productivity in the U.S.* data.
Average annual change for the U.S. was -0.10 percent for the period 1960-2004.

Change in agricultural productivity by State, 1960-2004

Average annual change (percent)



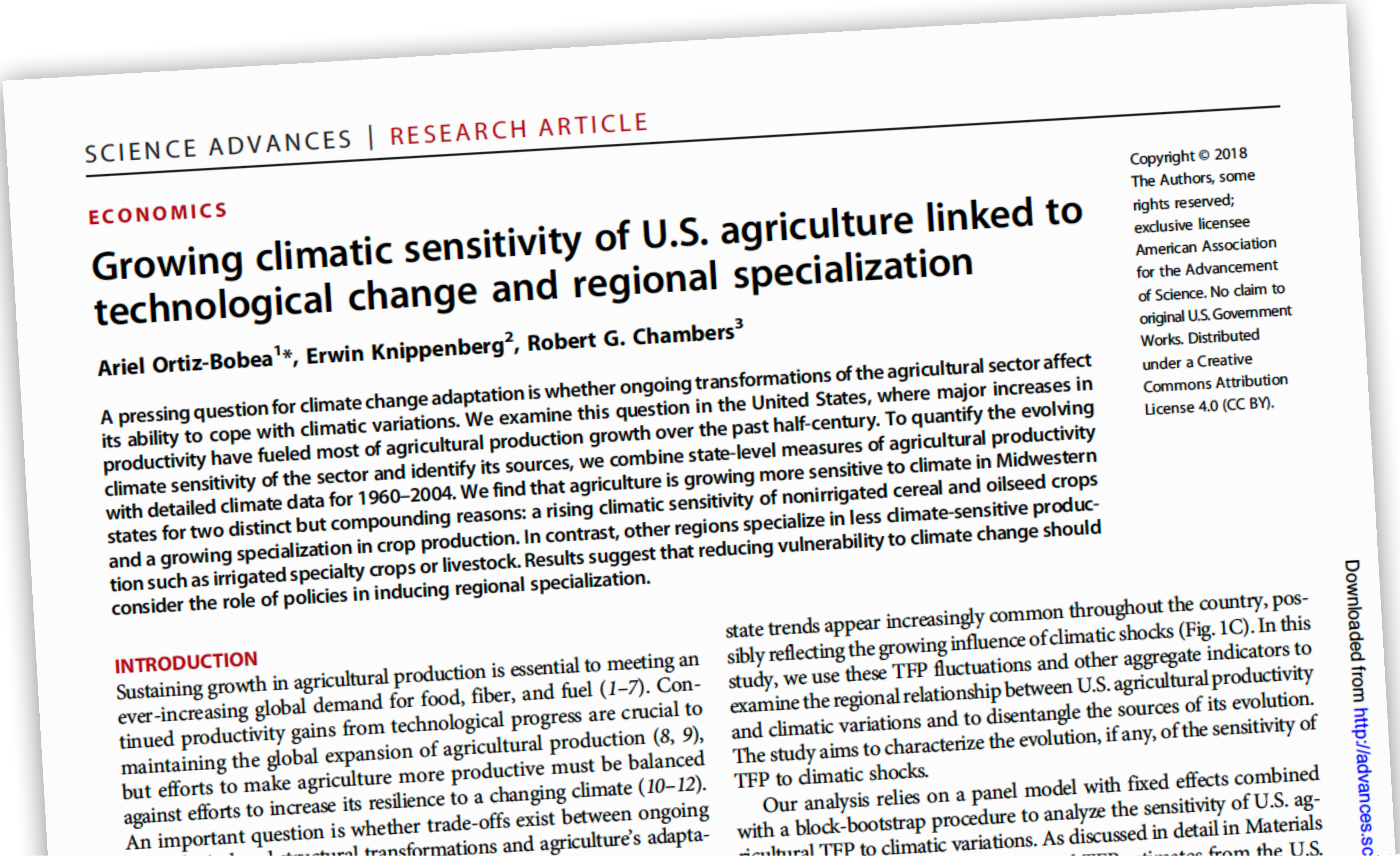
Source: ERS data product, Agricultural Productivity in the United States.
Average annual growth for the U.S. was 1.76 percent for the period 1960-2004.

Links to:

Paper and Appendix

Code and data

Press release



SCIENCE ADVANCES | RESEARCH ARTICLE

ECONOMICS

Growing climatic sensitivity of U.S. agriculture linked to technological change and regional specialization

Ariel Ortiz-Bobea[1]*, Erwin Knippenberg[2], Robert G. Chambers[3]

A pressing question for climate change adaptation is whether ongoing transformations of the agricultural sector affect its ability to cope with climatic variations. We examine this question in the United States, where major increases in productivity have fueled most of agricultural production growth over the past half-century. To quantify the evolving climate sensitivity of the sector and identify its sources, we combine state-level measures of agricultural productivity with detailed climate data for 1960–2004. We find that agriculture is growing more sensitive to climate in Midwestern states for two distinct but compounding reasons: a rising climatic sensitivity of nonirrigated cereal and oilseed crops and a growing specialization in crop production. In contrast, other regions specialize in less climate-sensitive production such as irrigated specialty crops or livestock. Results suggest that reducing vulnerability to climate change should consider the role of policies in inducing regional specialization.

INTRODUCTION

Sustaining growth in agricultural production is essential to meeting an ever-increasing global demand for food, fiber, and fuel (*1–7*). Continued productivity gains from technological progress are crucial to maintaining the global expansion of agricultural production (*8*, *9*), but efforts to make agriculture more productive must be balanced against efforts to increase its resilience to a changing climate (*10–12*). An important question is whether trade-offs exist between ongoing

state trends appear increasingly common throughout the country, possibly reflecting the growing influence of climatic shocks (Fig. 1C). In this study, we use these TFP fluctuations and other aggregate indicators to examine the regional relationship between U.S. agricultural productivity and climatic variations and to disentangle the sources of its evolution. The study aims to characterize the evolution, if any, of the sensitivity of TFP to climatic shocks.

Our analysis relies on a panel model with fixed effects combined with a block-bootstrap procedure to analyze the sensitivity of U.S. agricultural TFP to climatic variations. As discussed in detail in Materials

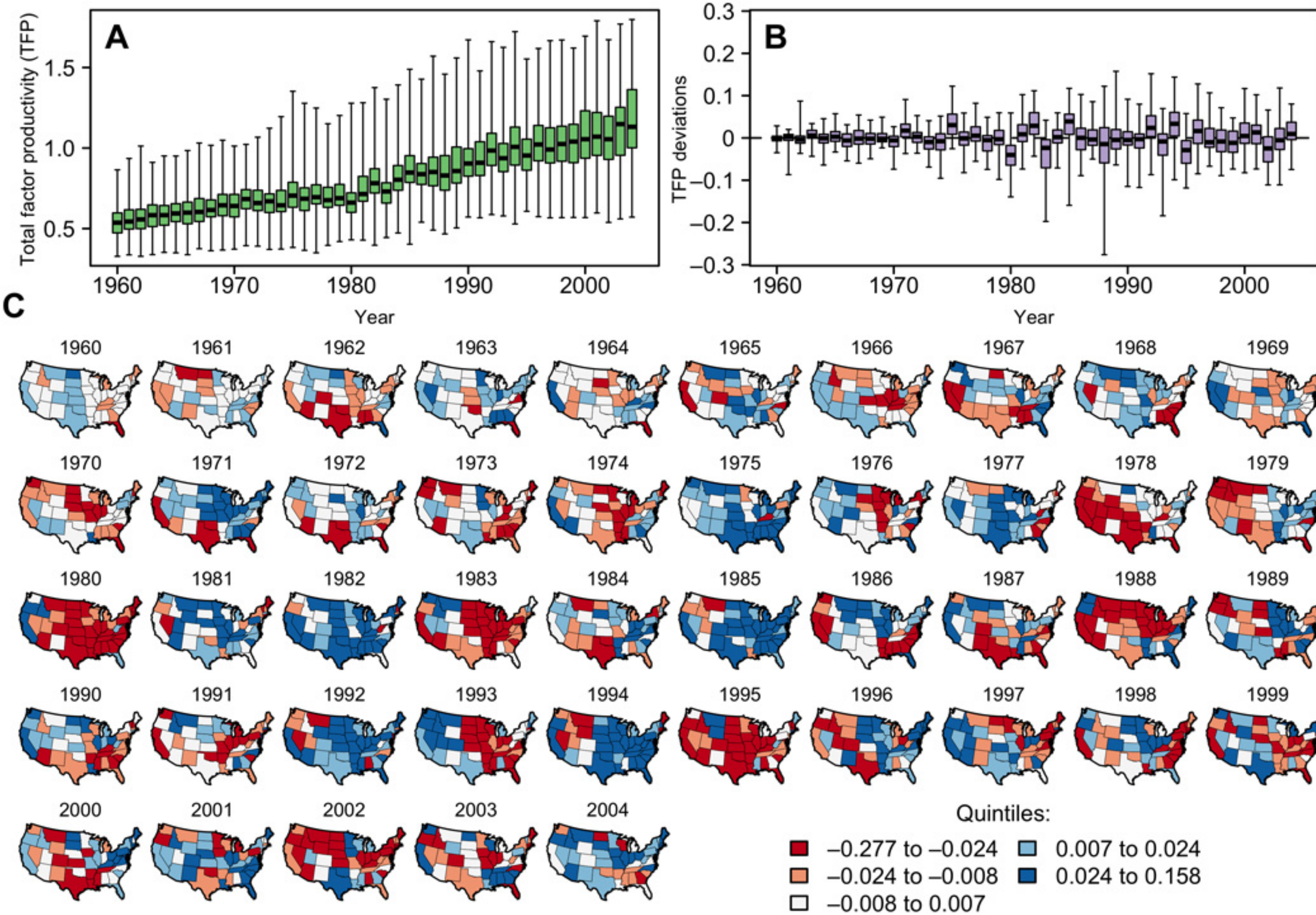


Fig. 1 TFP distribution and deviations.

(A) Distribution of TFP across the continental United States by year over 1960–2004. The box represents the first three quartiles, and whiskers extend to the extremes. TFP is normalized to 1 for Alabama in 1996. (B) Deviations in TFP from the trend based on a state-specific Hodrick-Prescott (HP) decomposition (see Materials and Methods). Boxes and whiskers are defined as for the level data. (C) Maps show yearly TFP deviations from state-level trend. The color scale corresponds to quintiles.

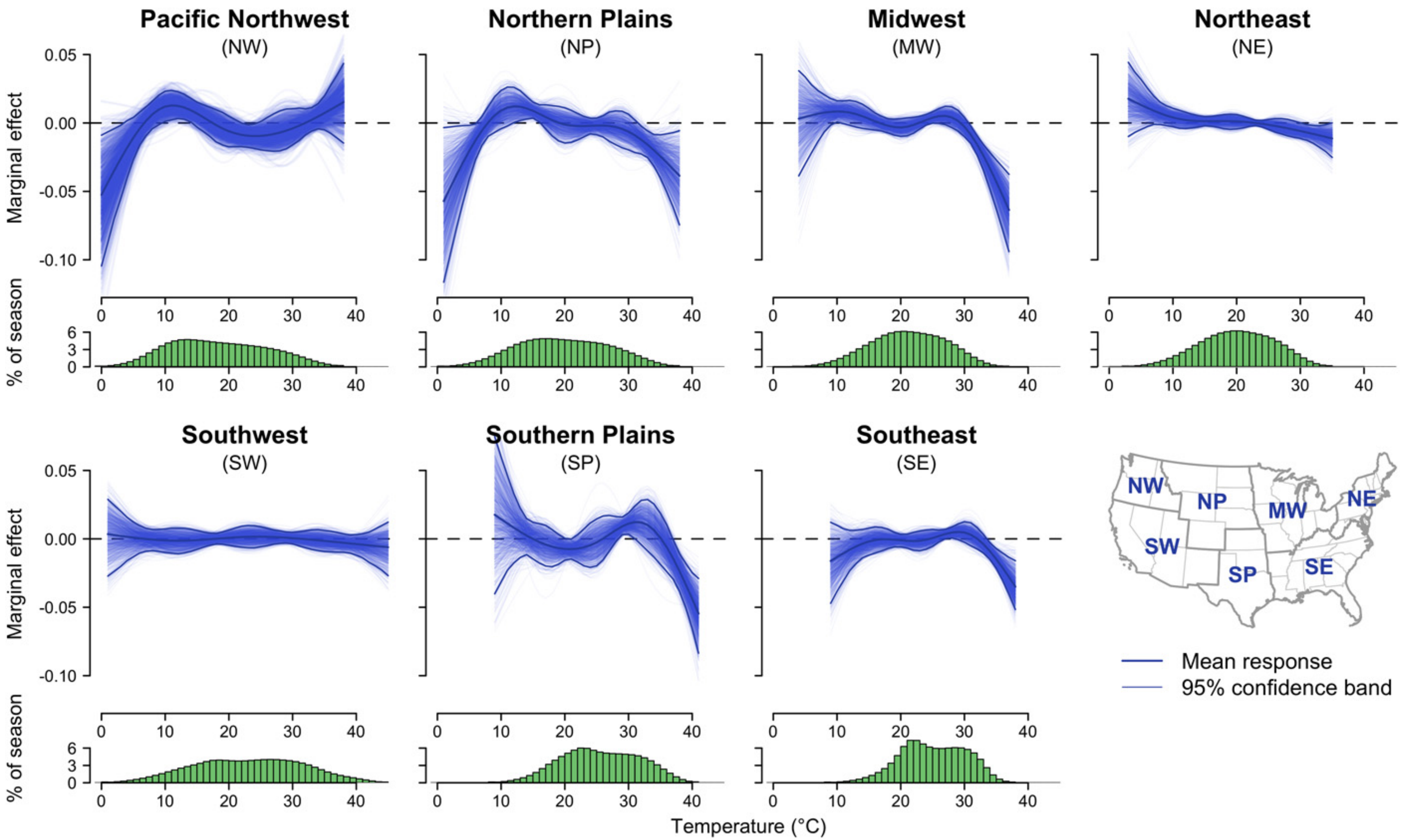


Fig. 2 Productivity response to summer temperature by region.

The overlay of blue response functions for each region corresponds to 1000 response functions derived from bootstrapped regressions in which years of data (1960–2004) were sampled with replacement. Mean and 95% confidence bands derived from the bootstrapped regressions are represented in darker lines. Functions were estimated separately for each USDA Climate Hub region based on state-level TFP and summer (June to August) weather data (see Materials and Methods). The green histograms below the response curves represent the percent of the time spent in each temperature bin during the summer season.

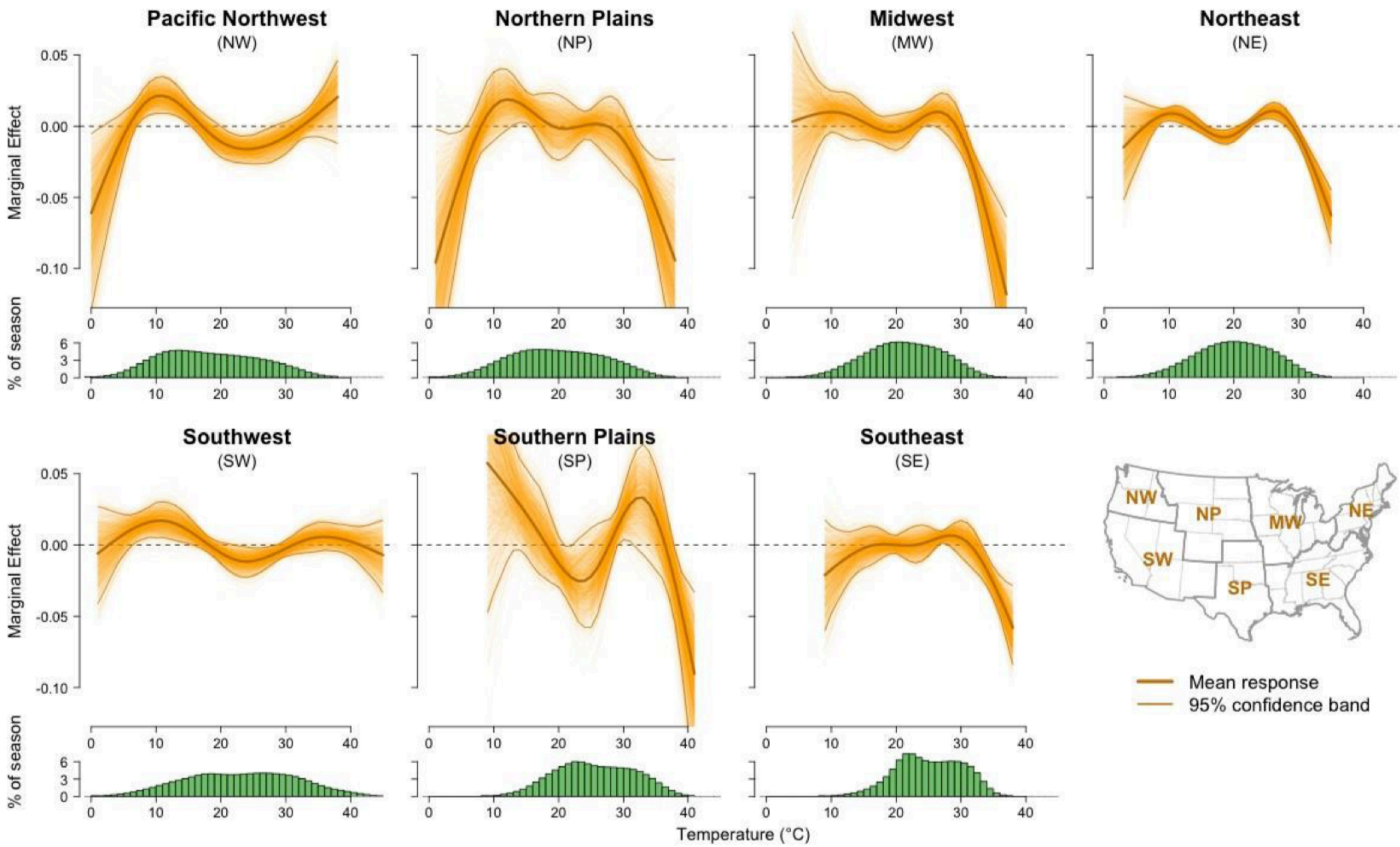


Fig. S12. Crop output response to summer temperature by region. The overlay of gold response functions for each region corresponds to 1,000 response functions derived from bootstrapped regressions in which years of data (1960-2004) were sampled with replacement. Mean and 95% confidence intervals are represented in darker lines. Functions were estimated separately for each USDA climate hub region based on state-level crop output and summer (June-August) weather data. The green histograms below the response curves represent the percent of the time spent in each temperature bin during the summer.

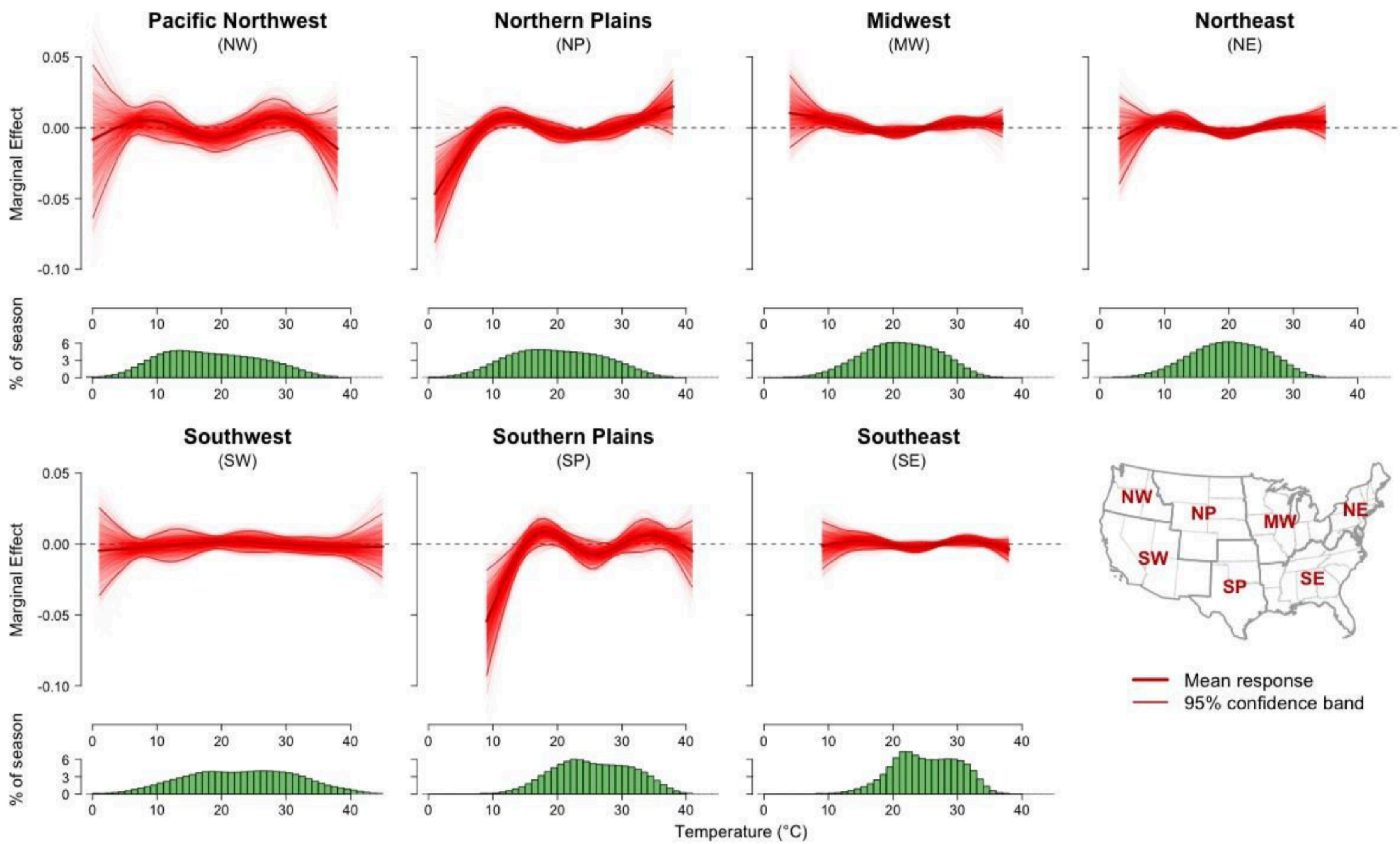


Fig. S17. Livestock output response to summer temperature by region. The overlay of gold response functions for each region corresponds to 1,000 response functions derived from bootstrapped regressions in which years of data (1960-2004) were sampled with replacement. Mean and 95% confidence intervals are represented in darker lines. Functions were estimated separately for each USDA climate hub region based on state-level crop output and summer (June-August) weather data. The green histograms below the response curves represent the percent of the time spent in each temperature bin during the summer.

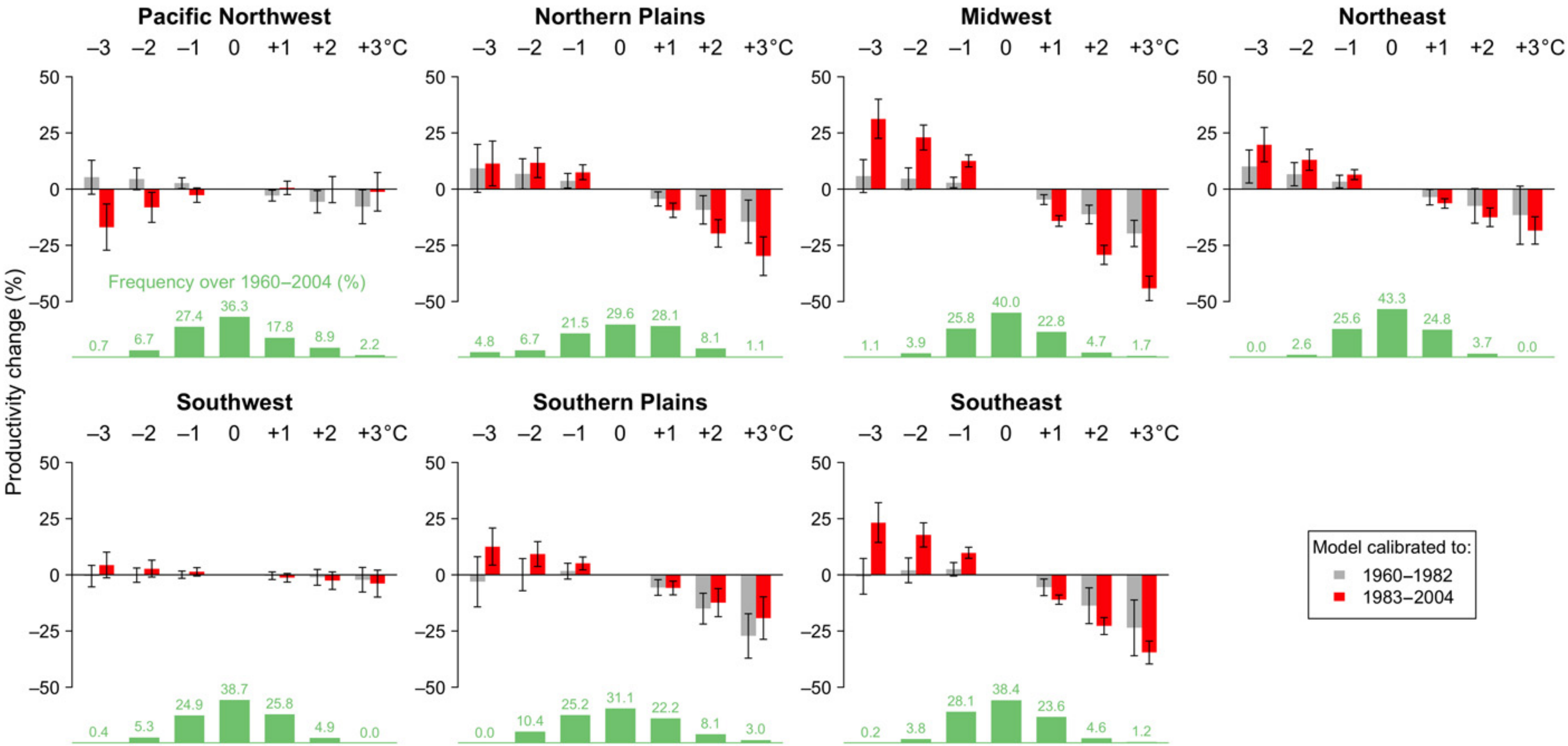


Fig. 3 Predicted productivity changes from summer temperature change.
Each panel represents the predicted changes in TFP corresponding to uniform changes of the entire summer temperature distribution. Predictions based on regressions calibrated with earlier data (1960–1982) are represented with gray bars, whereas predictions calibrated to more recent data (1983–2004) are represented with red bars. The error bars correspond to ±1 SD of the 1000 bootstrapped predictions. The green histogram represents the frequency of maximum summer temperature over the full sample period (1960–2004) and is presented for reference of the underlying distribution. The interval breaks fall within each full degree (e.g., the 2°C bin corresponds to summers between +1.5° and +2.5°C).

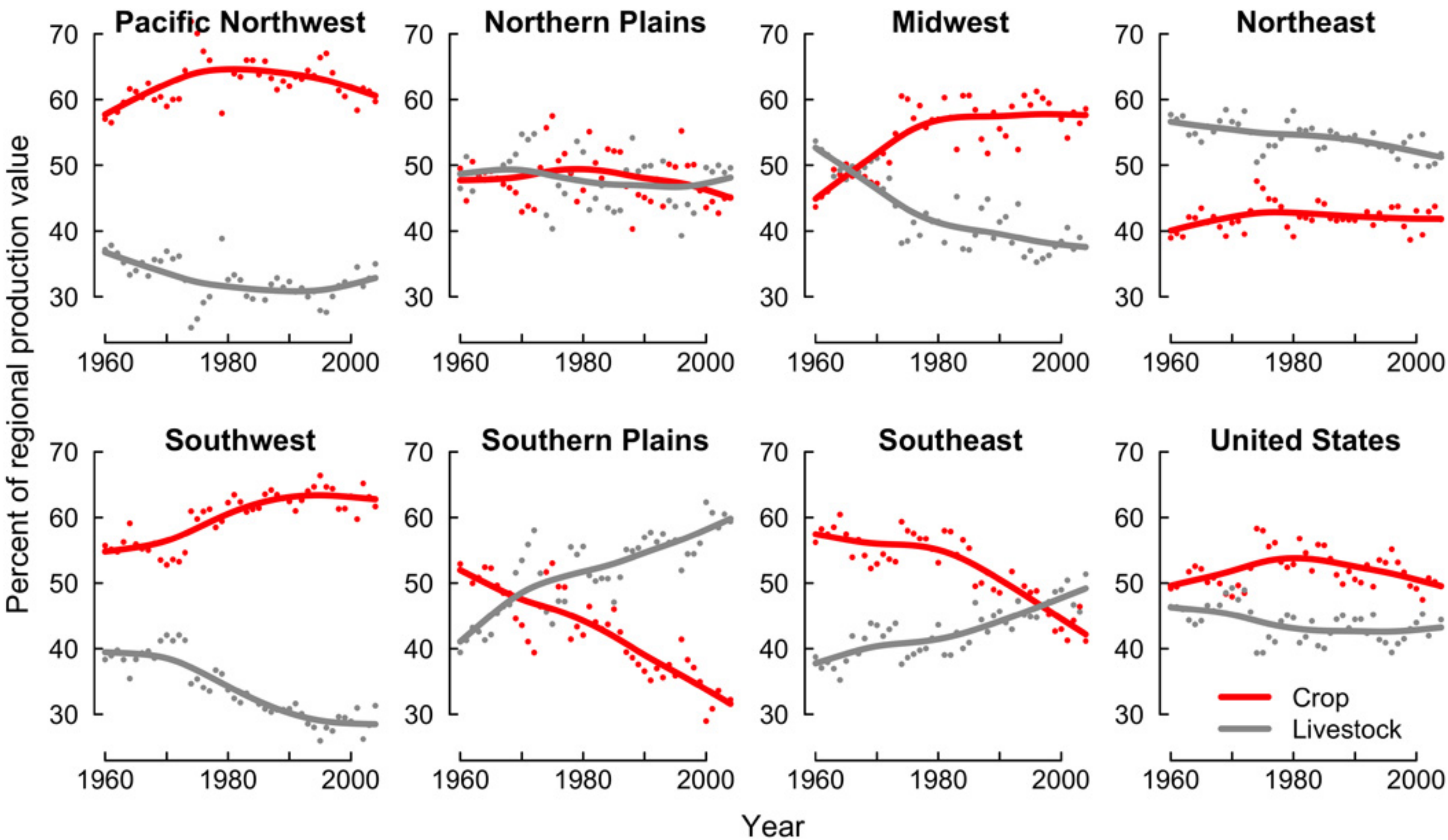
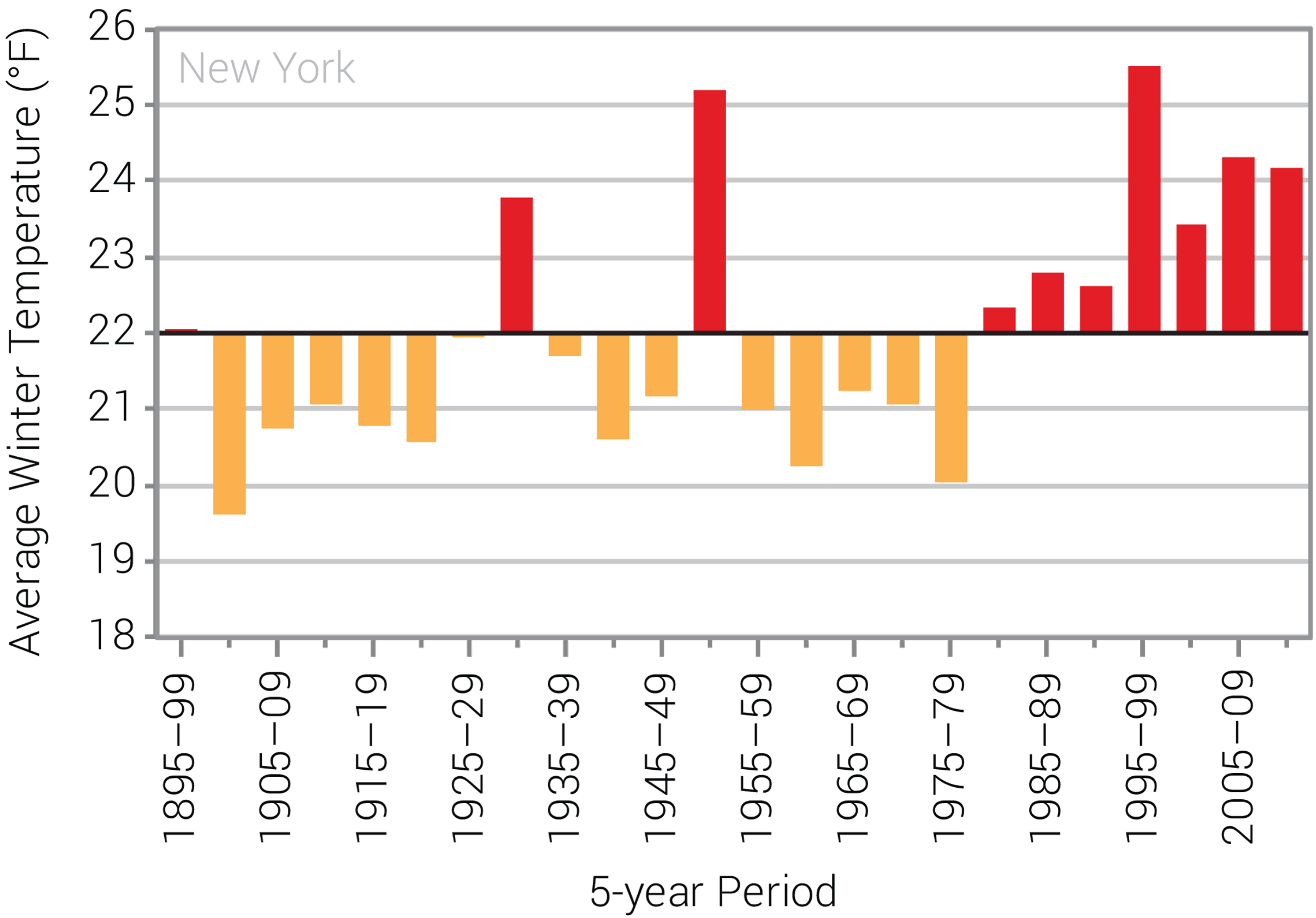


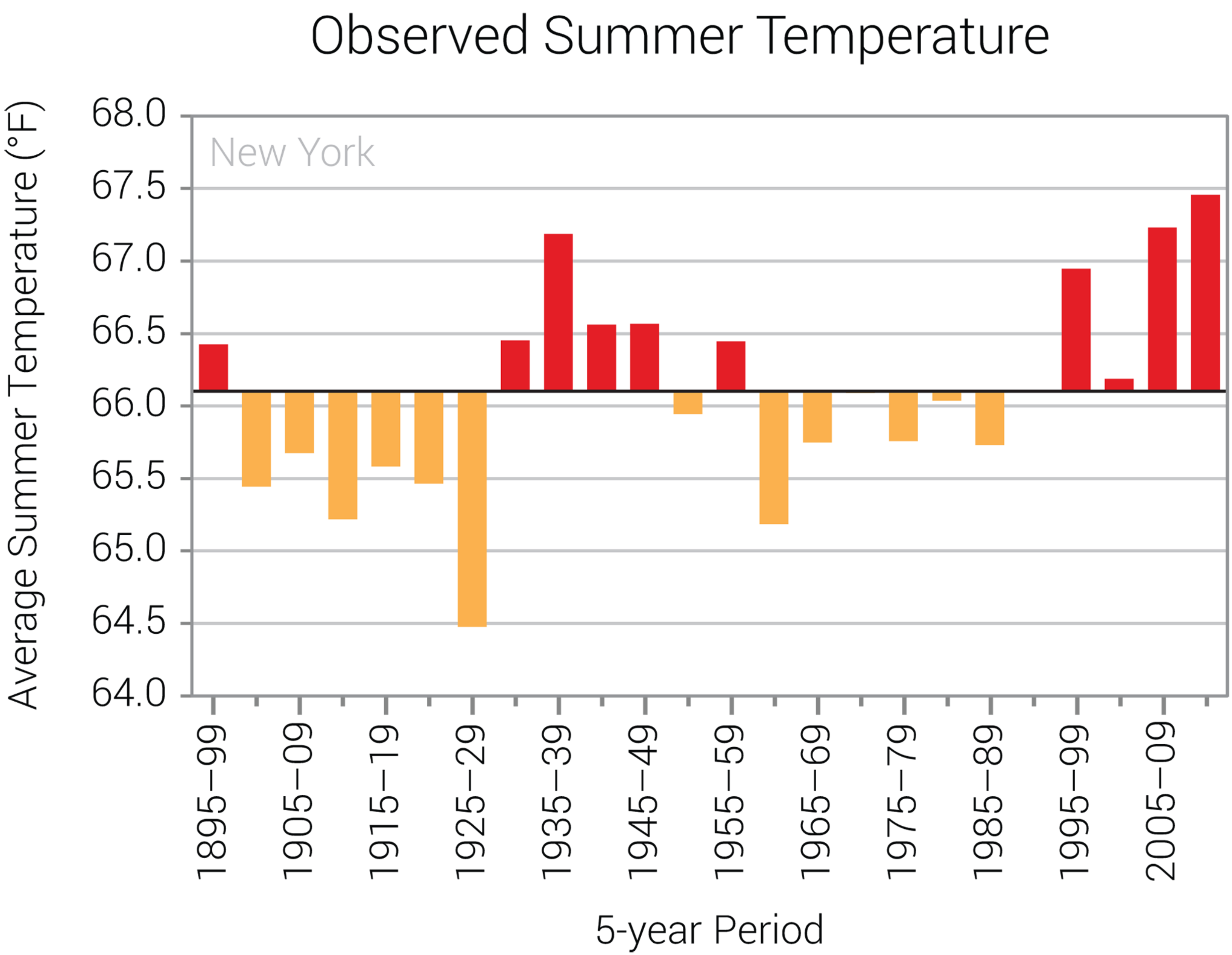
Fig. 4 Regional specialization.

Each panel represents the evolution of the share of each region's production value in crops (red) and livestock (gray). Points indicate yearly observations, and lines correspond to a smooth spline trend line.

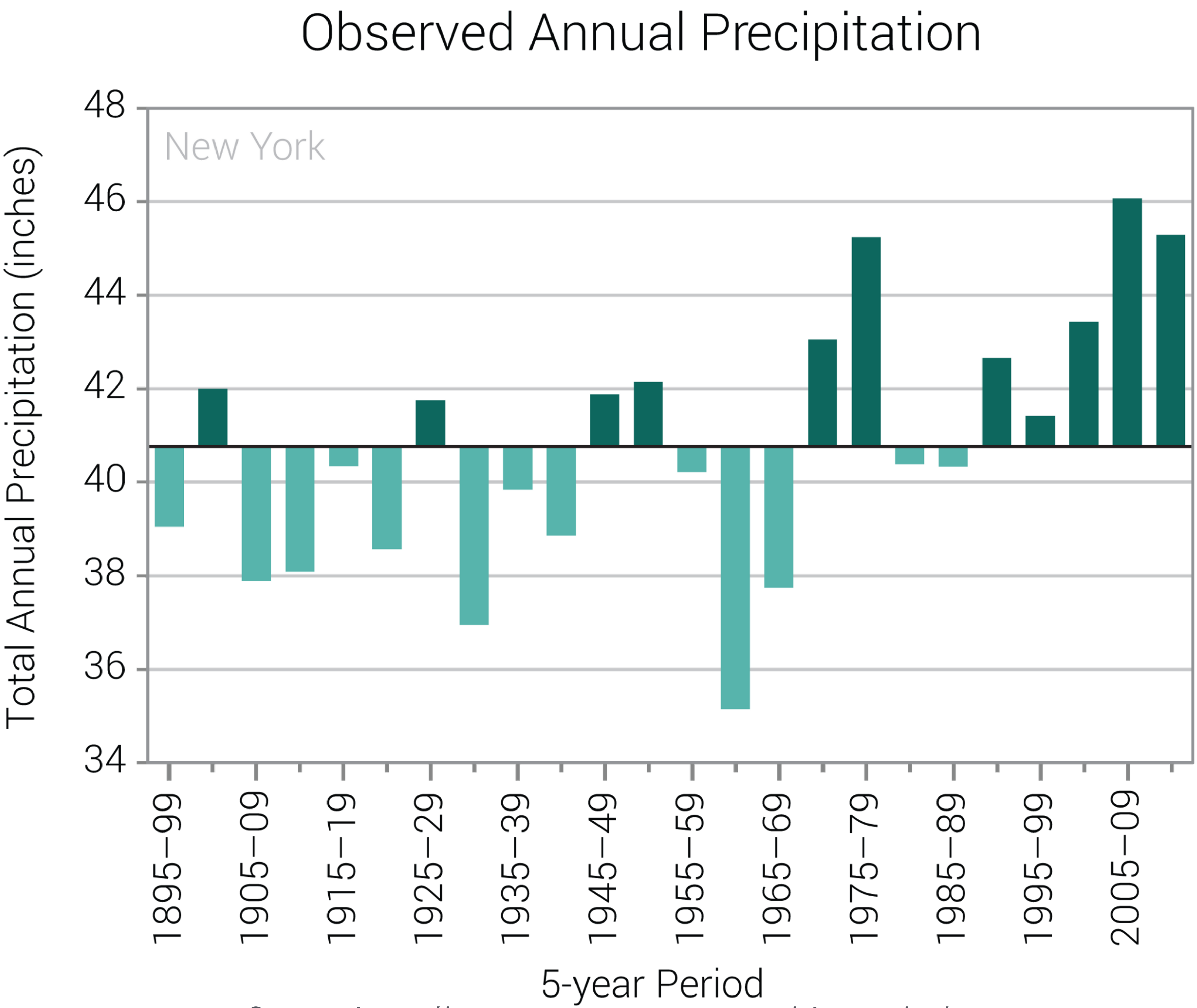
Observed Winter Temperature



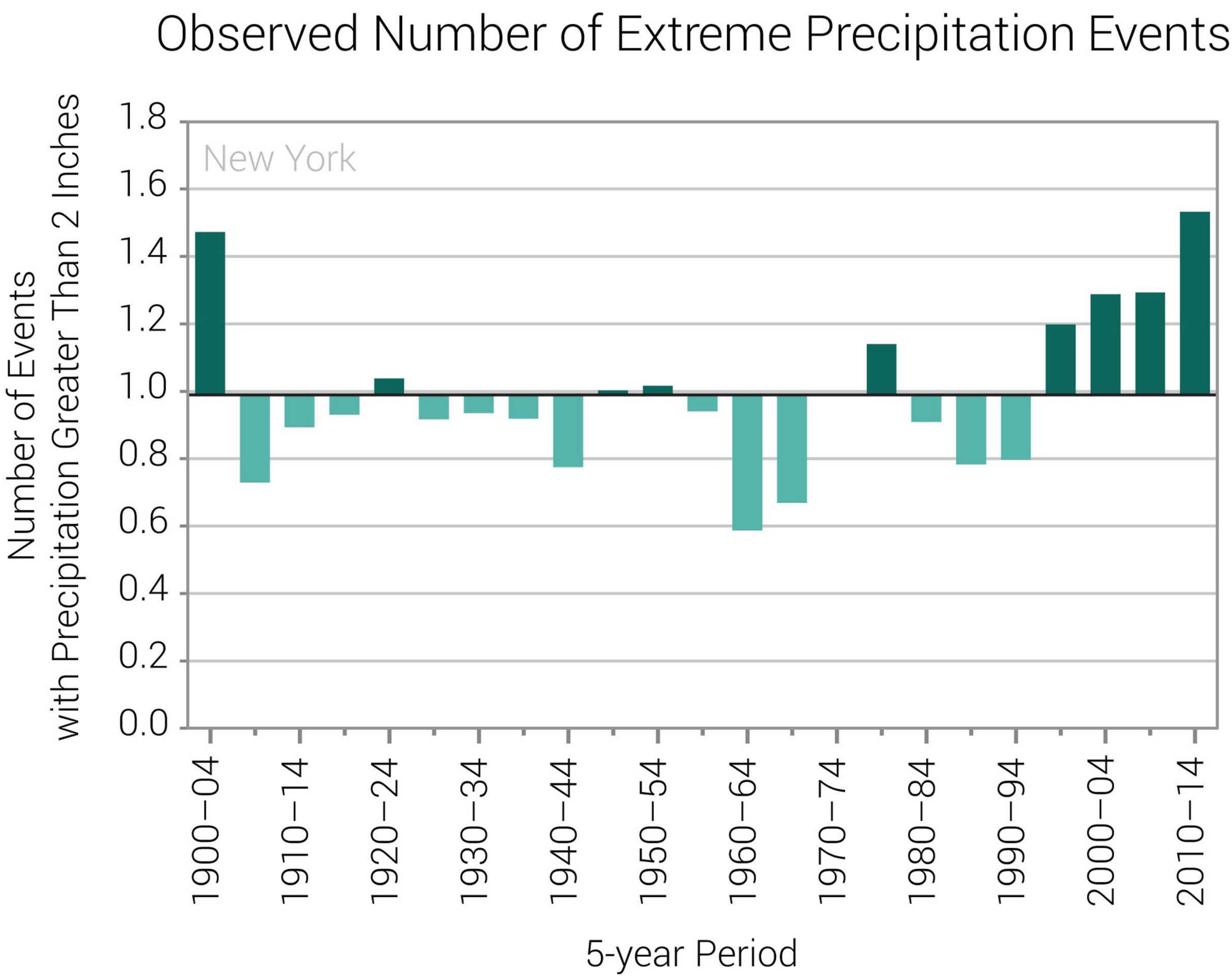
Source: https://statesummaries.ncics.org/chapter/ny/



Source: https://statesummaries.ncics.org/chapter/ny/



Source: https://statesummaries.ncics.org/chapter/ny/



Source: https://statesummaries.ncics.org/chapter/ny/

Projections for NY

- Warmer temperatures overal
- More precipitation and heavier downpours
- Wetter winter/spring, similar summer/fall
- Thus more frequent flooding in winter/spring and droughts in summer/fall
- Longer frost free period, but hotter summers
- Challenge: timely & cost-effective adaptation of NY farmers to changing climatic conditions

Estimated % of adults who think global warming is happening (67%), 2019

Select Question: Global warming is happening | Absolute Value

Click on map to select geography, or: Select a State | Select a County

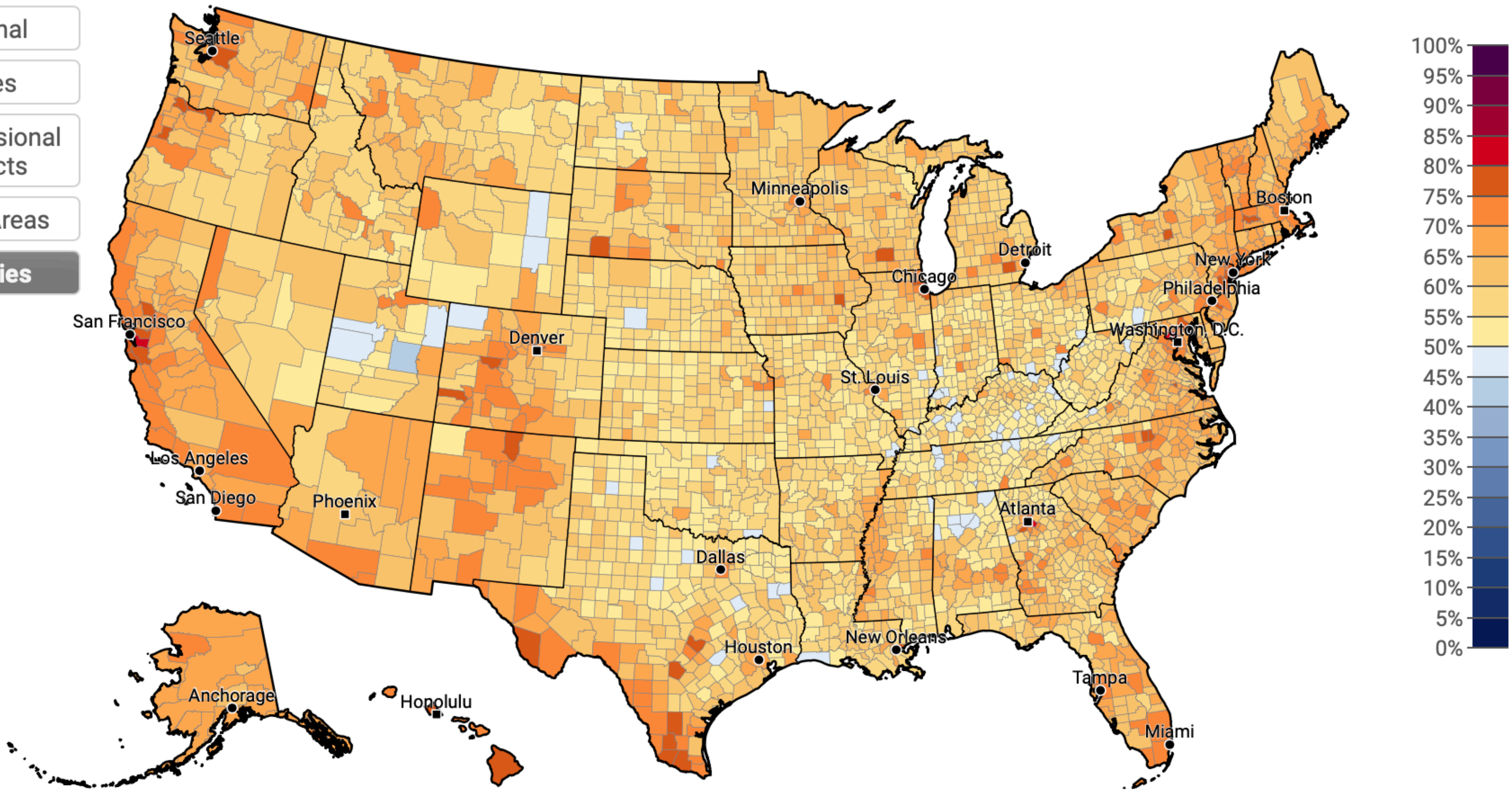
National

States

Congressional Districts

Metro Areas

Counties

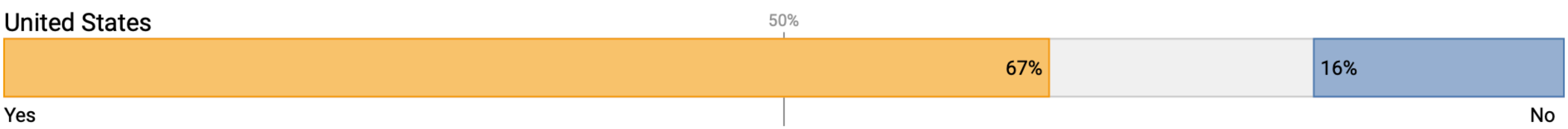


UCSB University of California Santa Barbara

Yale Program on Climate Change Communication

Utah State University

United States



Estimated % of adults who think global warming is mostly caused by human activities (53%), 2019

Select Question: Global warming is caused mostly by human activities | Absolute Value

Click on map to select geography, or: Select a State | Select a County

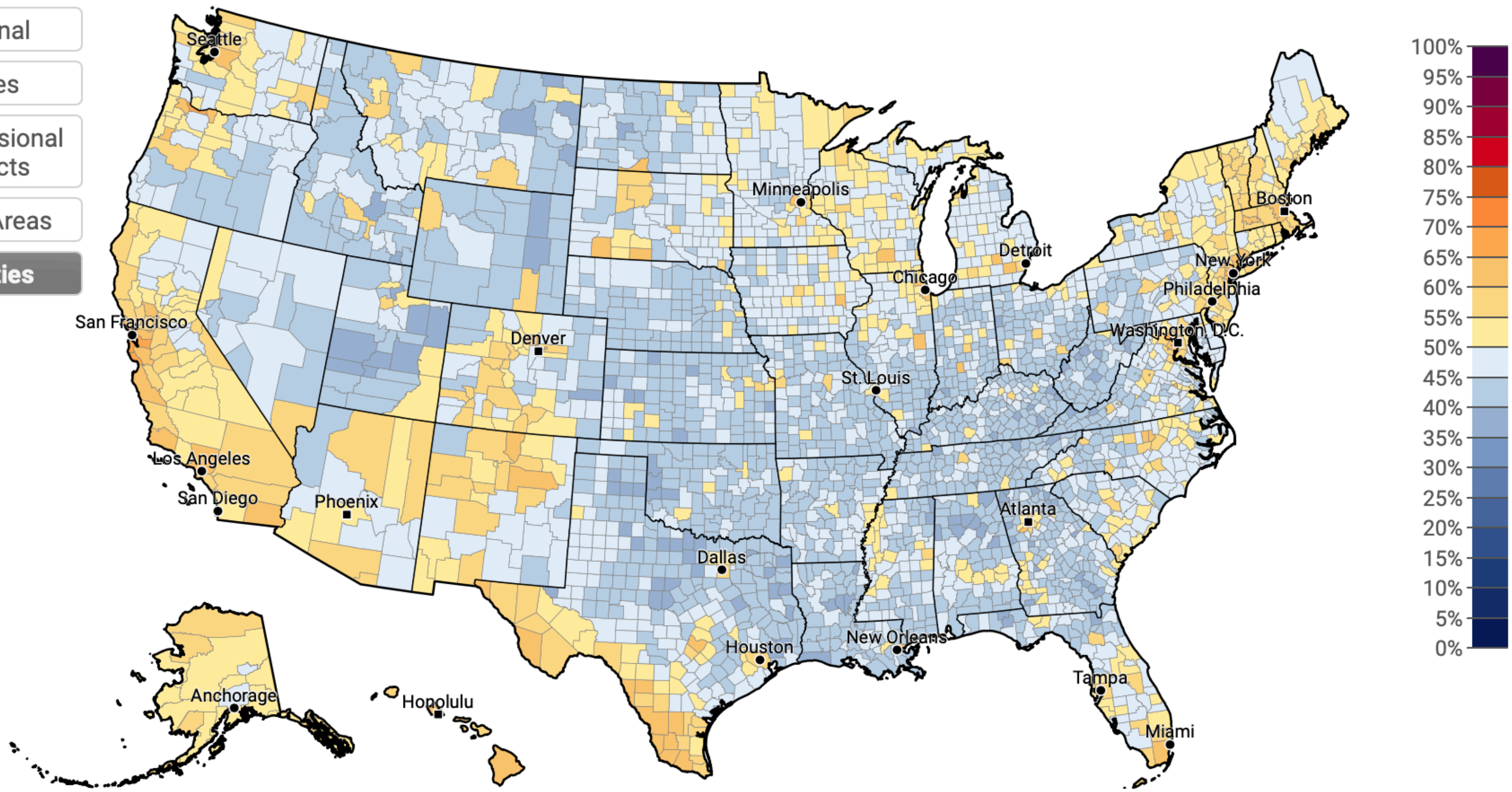
National

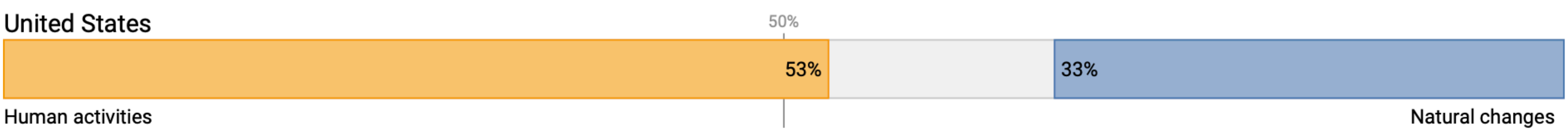
States

Congressional Districts

Metro Areas

Counties



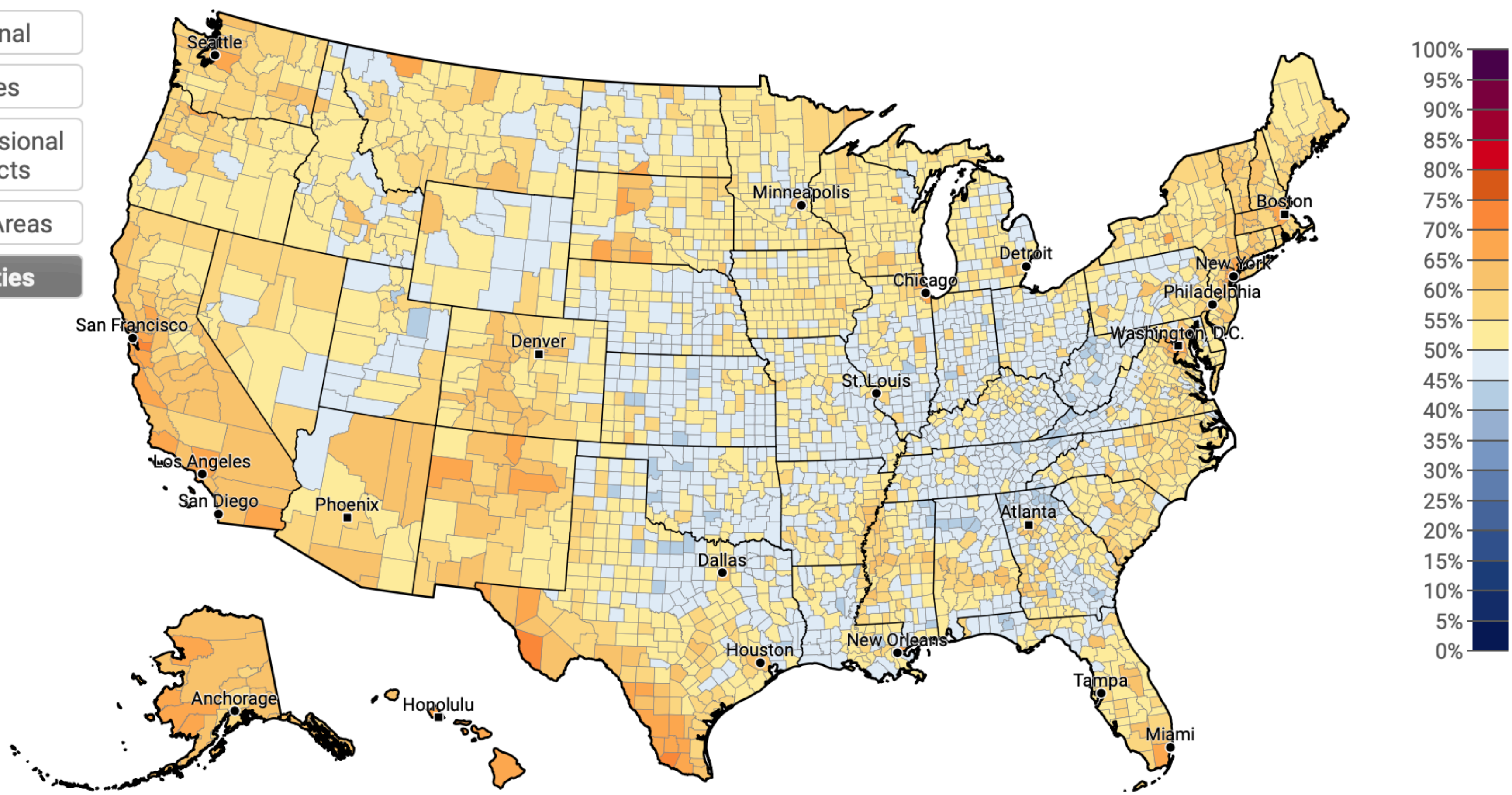


Estimated % of adults who think global warming will harm people in the US (57%), 2019

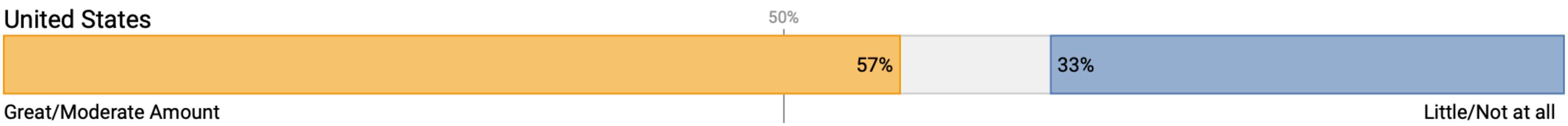
Select Question: Global warming will harm people in the US | Absolute Value

Click on map to select geography, or: Select a State | Select a County

- National
- States
- Congressional Districts
- Metro Areas
- **Counties**



United States



Estimated % of adults who think global warming is already harming people in the US now or within 10 years (48%), 2019

Select Question: Global warming is already harming people in the US | Absolute Value

Click on map to select geography, or: Select a State | Select a County

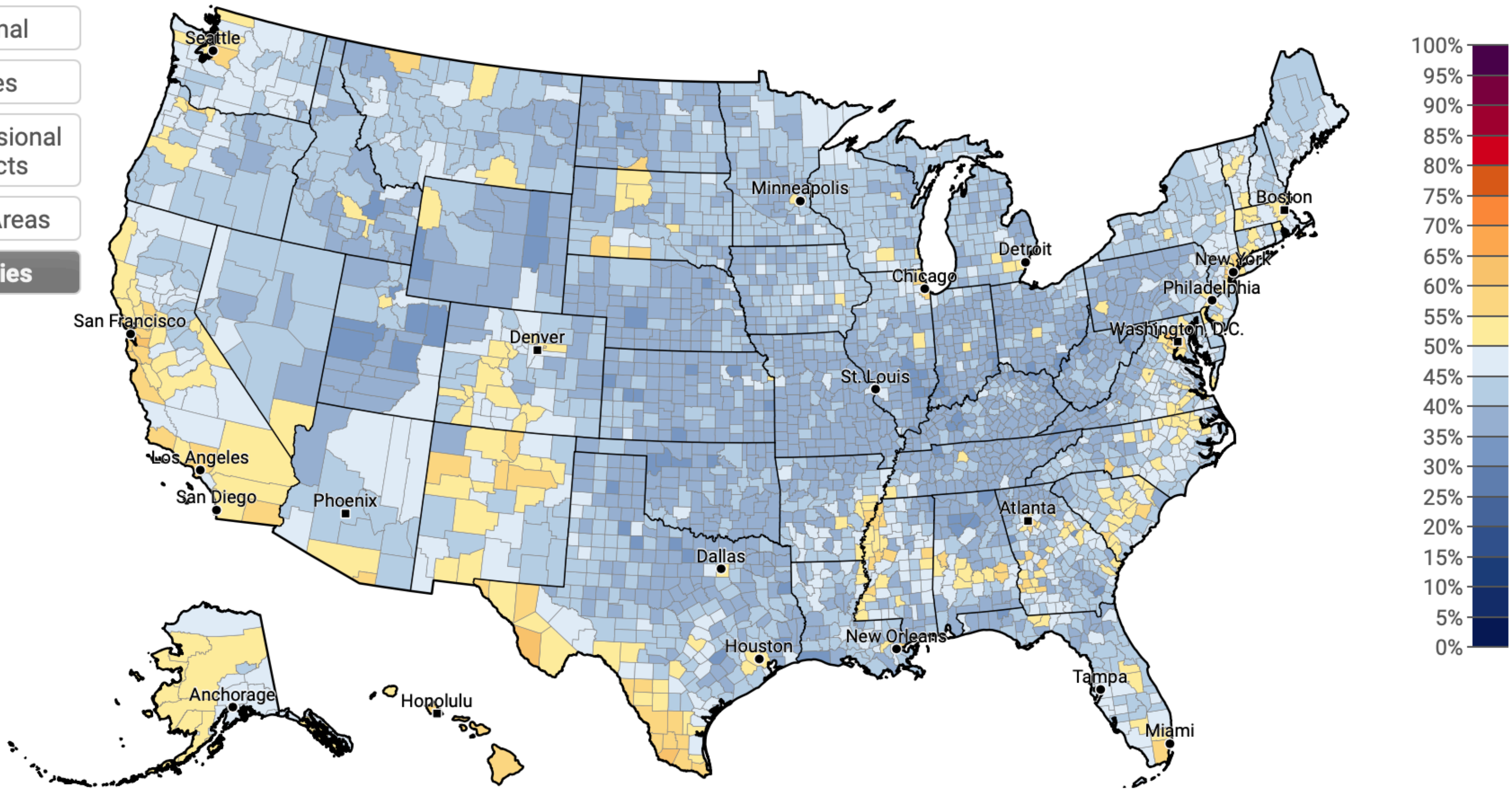
National

States

Congressional Districts

Metro Areas

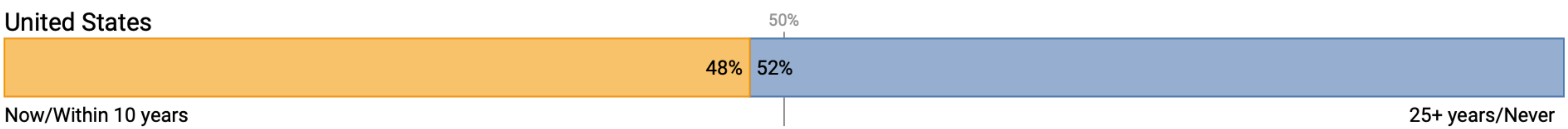
Counties



UCSB University of California Santa Barbara

Yale Program on Climate Change Communication

UtahState University



Estimated % of adults who think global warming will harm them personally (42%), 2019

Select Question: Global warming will harm me personally | Absolute Value

Click on map to select geography, or: Select a State | Select a County

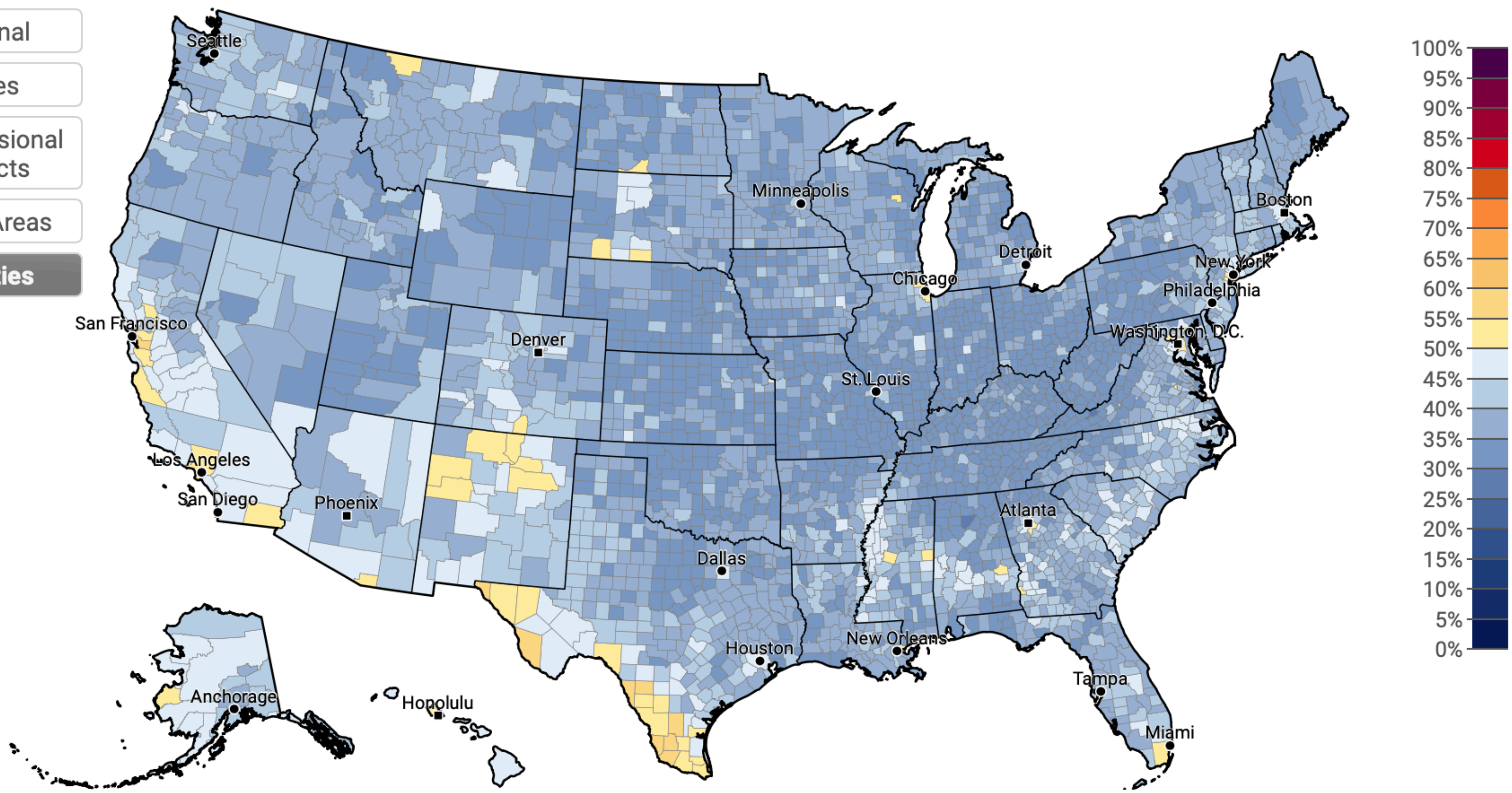
National

States

Congressional Districts

Metro Areas

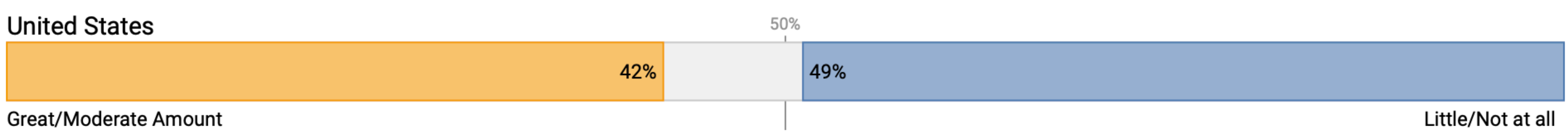
Counties



UCSB UNIVERSITY OF CALIFORNIA SANTA BARBARA

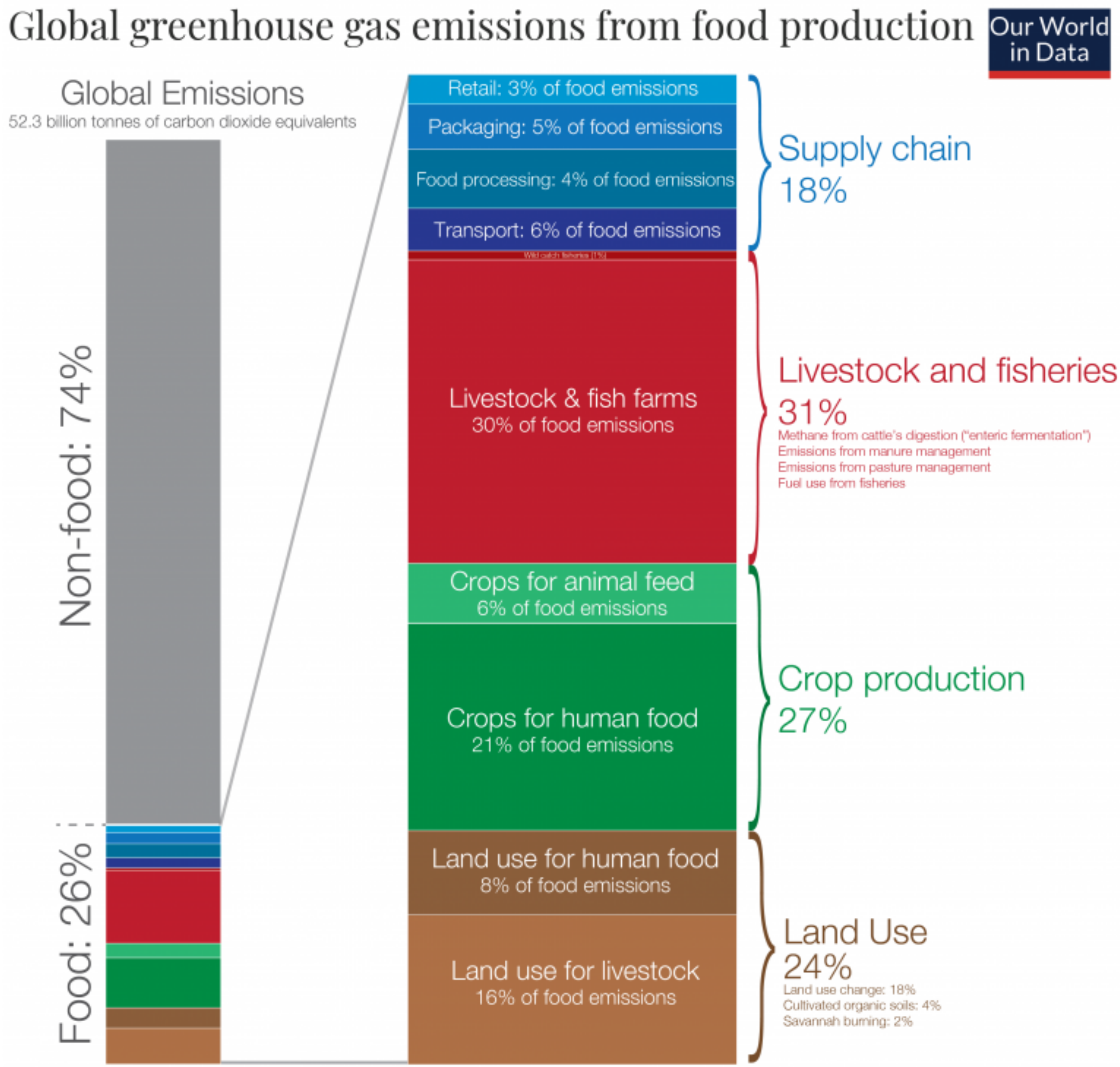
YALE PROGRAM ON Climate Change Communication

UtahState University



4. Opportunities

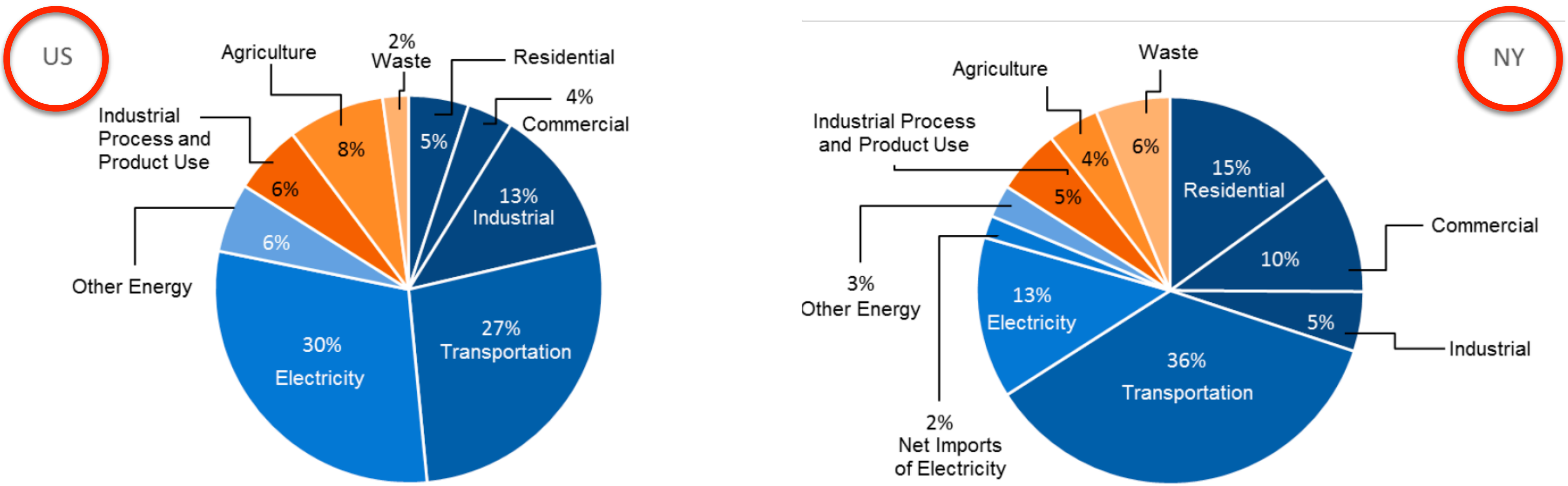
Global greenhouse gas emissions from food production



Data source: Joseph Poore & Thomas Nemecek (2018). Reducing food's environmental impacts through producers and consumers. Published in *Science*.
OurWorldinData.org – Research and data to make progress against the world's largest problems.

Figure S-6. 2016 GHG Emissions by Sector in New York State and U.S. by U.S. Economic Sector

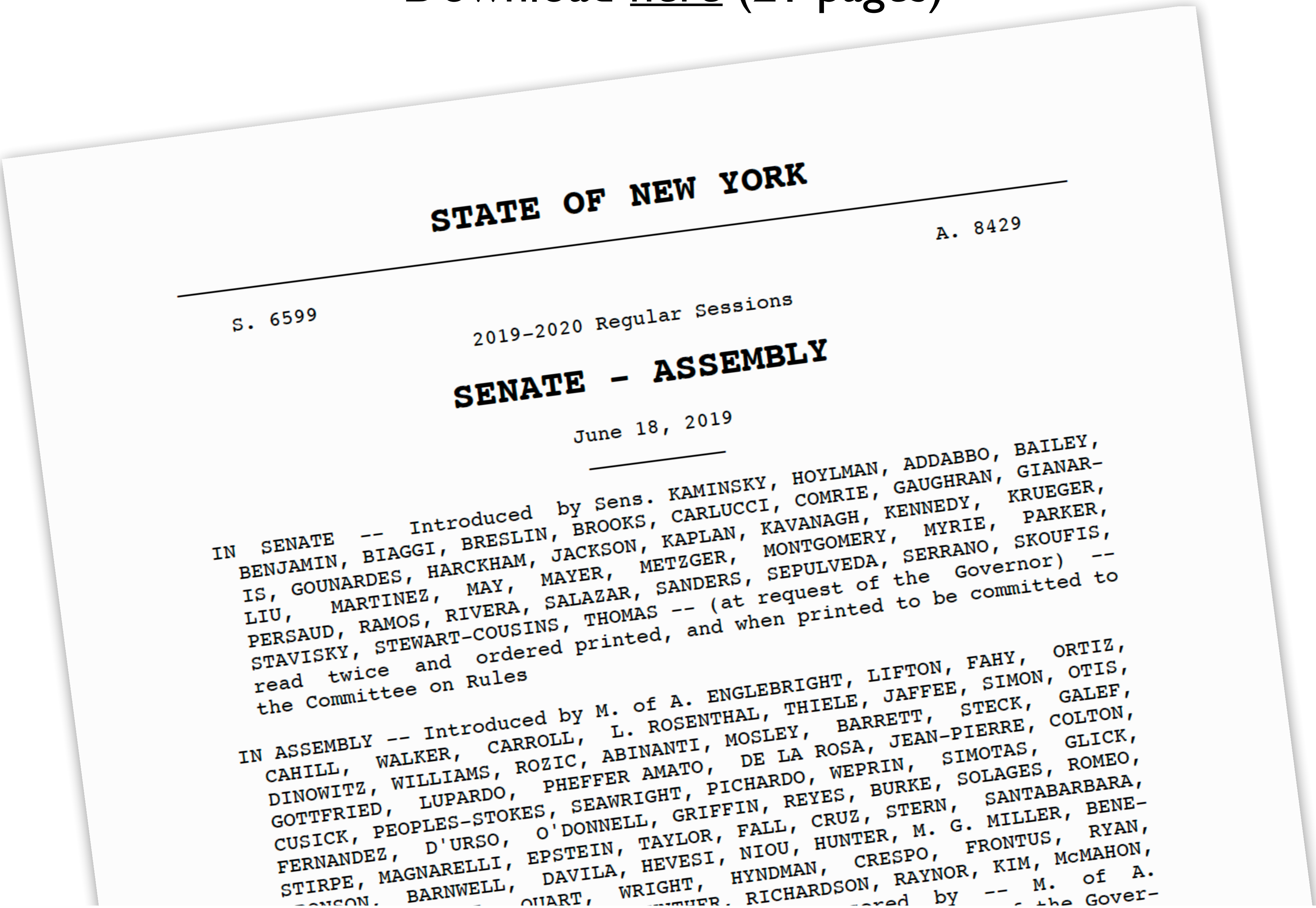
Note: These values may not sum directly due to independent rounding.



Source: https://www.nyserda.ny.gov/-/media/Files/EDPPP/Energy-Prices/Energy-Statistics/greenhouse-gas-inventory.pdf

NYS Senate Bill S6599

Download here (21 pages)



STATE OF NEW YORK

S. 6599 A. 8429

2019-2020 Regular Sessions

SENATE - ASSEMBLY

June 18, 2019

IN SENATE -- Introduced by Sens. KAMINSKY, HOYLMAN, ADDABBO, BAILEY, BENJAMIN, BIAGGI, BRESLIN, BROOKS, CARLUCCI, COMRIE, GAUGHRAN, GIANARIS, GOUNARDES, HARCKHAM, JACKSON, KAPLAN, KAVANAGH, KENNEDY, KRUEGER, LIU, MARTINEZ, MAY, MAYER, METZGER, MONTGOMERY, MYRIE, PARKER, PERSAUD, RAMOS, RIVERA, SALAZAR, SANDERS, SEPULVEDA, SERRANO, SKOUFIS, STAVISKY, STEWART-COUSINS, THOMAS -- (at request of the Governor) -- read twice and ordered printed, and when printed to be committed to the Committee on Rules

IN ASSEMBLY -- Introduced by M. of A. ENGLEBRIGHT, LIFTON, FAHY, ORTIZ, CAHILL, WALKER, CARROLL, L. ROSENTHAL, THIELE, JAFFEE, SIMON, OTIS, DINOWITZ, WILLIAMS, ROZIC, ABINANTI, MOSLEY, BARRETT, STECK, GALEF, GOTTFRIED, LUPARDO, PHEFFER AMATO, DE LA ROSA, JEAN-PIERRE, COLTON, CUSICK, PEOPLES-STOKES, SEAWRIGHT, PICHARDO, WEPRIN, SIMOTAS, GLICK, FERNANDEZ, D'URSO, O'DONNELL, GRIFFIN, REYES, BURKE, SOLAGES, ROMEO, STIRPE, MAGNARELLI, EPSTEIN, TAYLOR, FALL, CRUZ, STERN, SANTABARBARA, BARNWELL, DAVILA, HEVESI, NIOU, HUNTER, M. G. MILLER, BENE- WRIGHT, HYNDMAN, CRESPO, FRONTUS, RYAN, RICHARDSON, RAYNOR, KIM, McMAHON, by -- M. of A.

S6599 summary

- Reduce greenhouse gases 100% over 1990 levels by 2050
- Establishment of a *"climate action council"* (22 members: 12 agency heads + 10 at large members)
- Council established *"advisory panels"* in various areas, including agriculture and forestry
- Council has 2 years to complete a *"scoping"* plan to recommend regulatory measures to meet goals, including *"measures to achieve carbon sequestration and/or promote best management practices in land use, agriculture and forestry"*

Many opportunities for GHG emissions reduction

(ideas from Peter Woodbury)

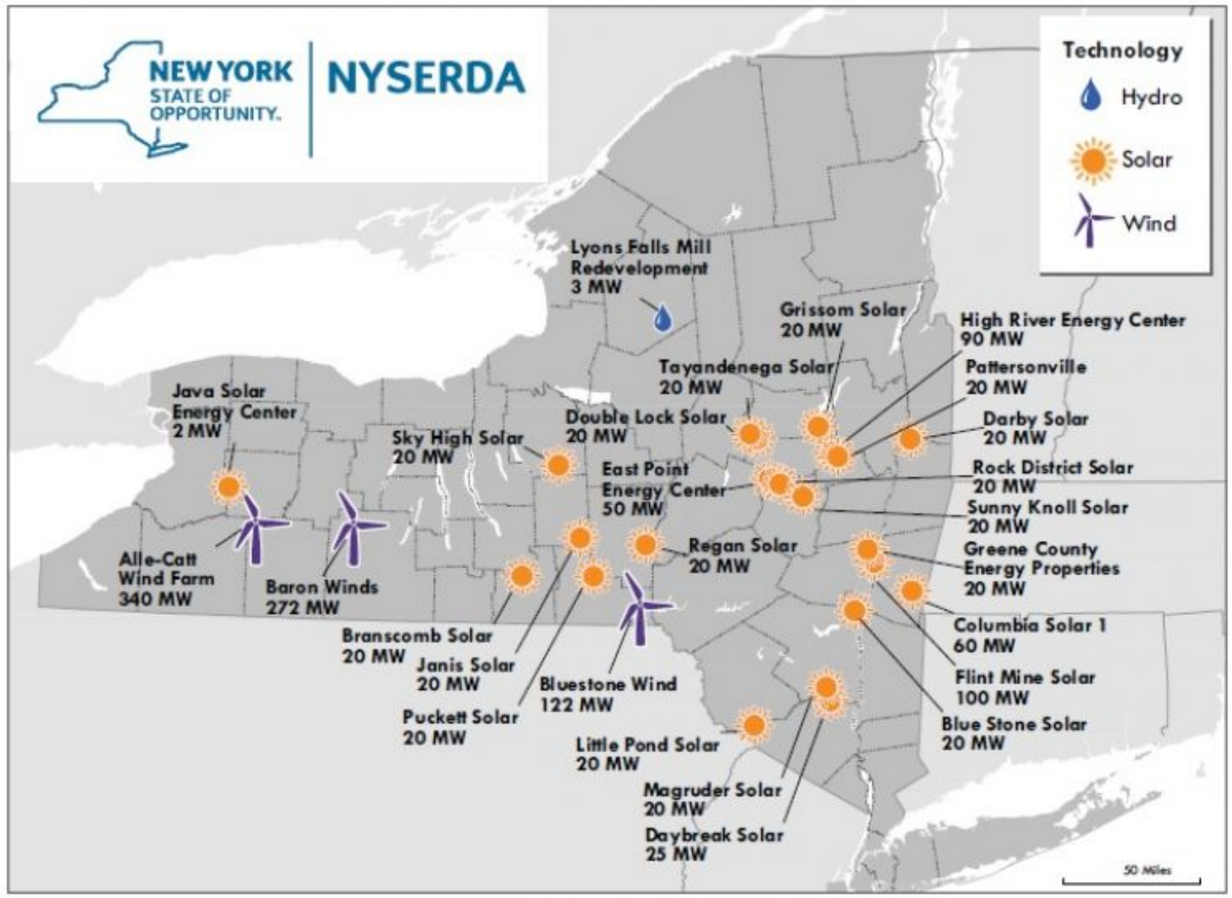
- Improved efficiency of crop and livestock production
- Improved soil health (more carbon)
- Cover crops and double crops
- Perennials in place of annuals
- Cropland nutrient management

Paradigm shift

- Carbon sequestration would become as new type of agricultural production
- Farmers provide a service to society
- Design of market is critical to make this sustainable
- Reduce risk of unintended consequences

Other opportunities (and challenges) from changing land use

- Leasing farmland for renewable energy production
- Cornell is starting an USDA/NSF-funded research project on "*ag-to-energy land use transitions*"



Thank you

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