

IAV Science Questions that Require Coupling and/or Inputs from IAM/ESM

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with input from:

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Workshop on
Climate Change Impacts and integrated Assessment
Snowmass Colorado
July 25, 2016

Outline

“Together We Are More”

- Trends IAV Research – As Snowmass Perspective
- Evidence from IPCC, NCA, etc.
- Needs from IAM/ESM communities

Trends in IAV Analyses

- More geographical resolution
- More ground truthing with observations
- More focus on extremes than means
- More attention to income distribution
- Better understanding of interactions
 - Between climate and society
 - Between sectors (inc. GE and Growth)
 - Between mitigation and adaptation
 - Between regions
- More Sectors - ocean acid., conflict, migration
- Better understanding of catastrophies/hazards

IPCC AR5 Working Group II Overview



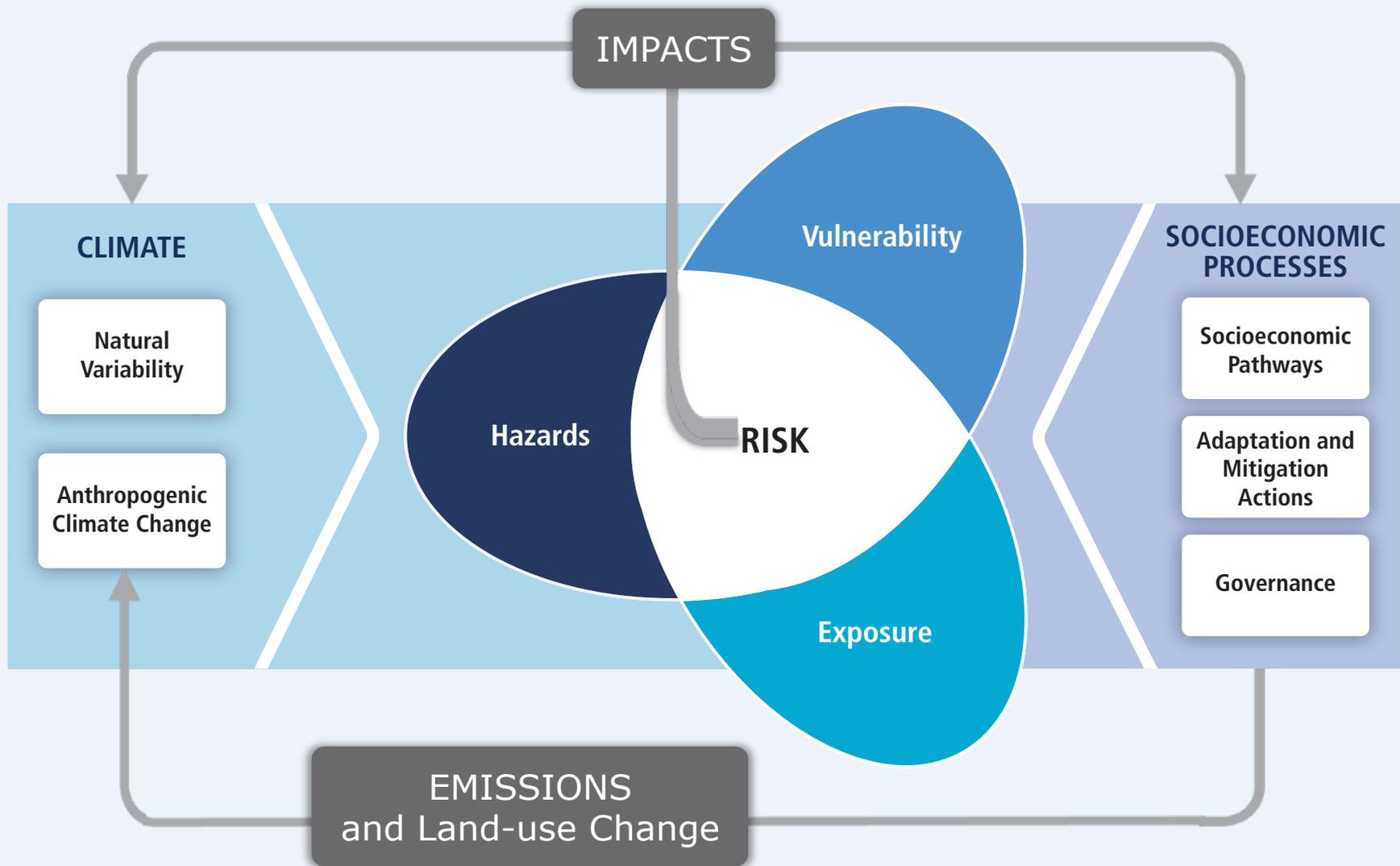
Katharine Mach

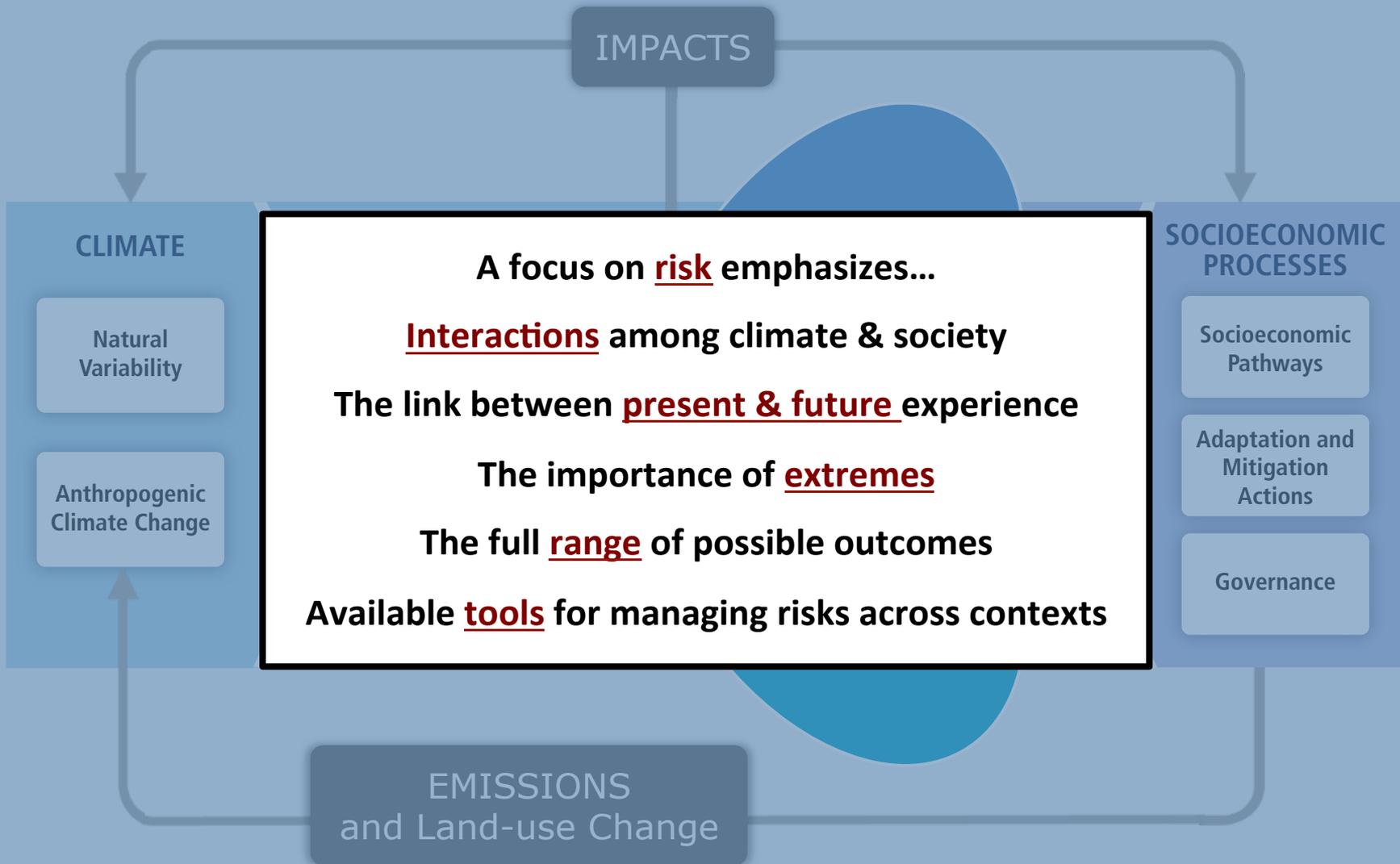
CARNEGIE SCIENCE

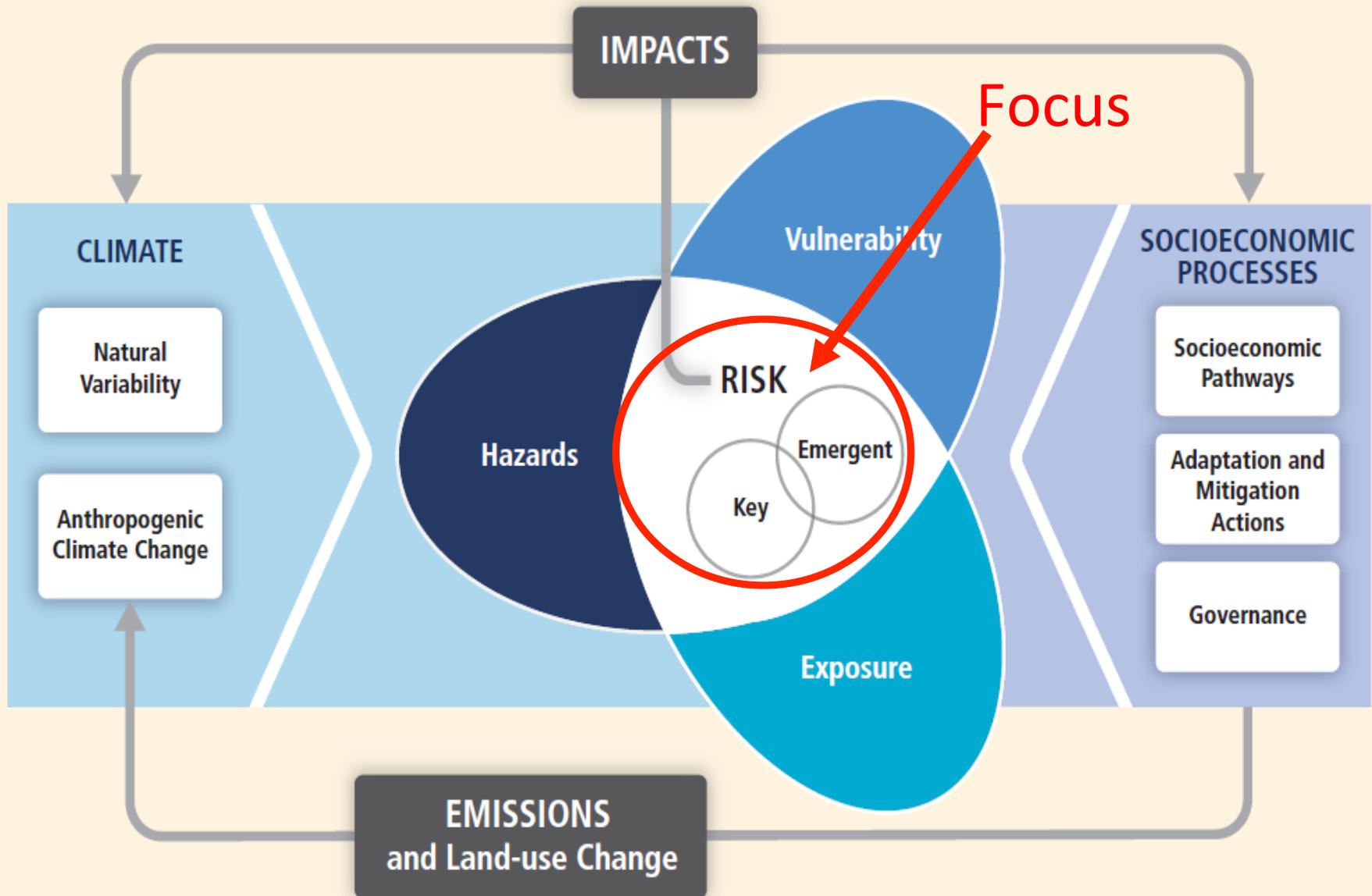


CLIMATE CHANGE

UNDERSTANDING,
MANAGING, &
REDUCING RISKS







Worldwide Effects

atmosphere, land, ocean

extreme events

water cycle

sea ice, glaciers, ice sheets

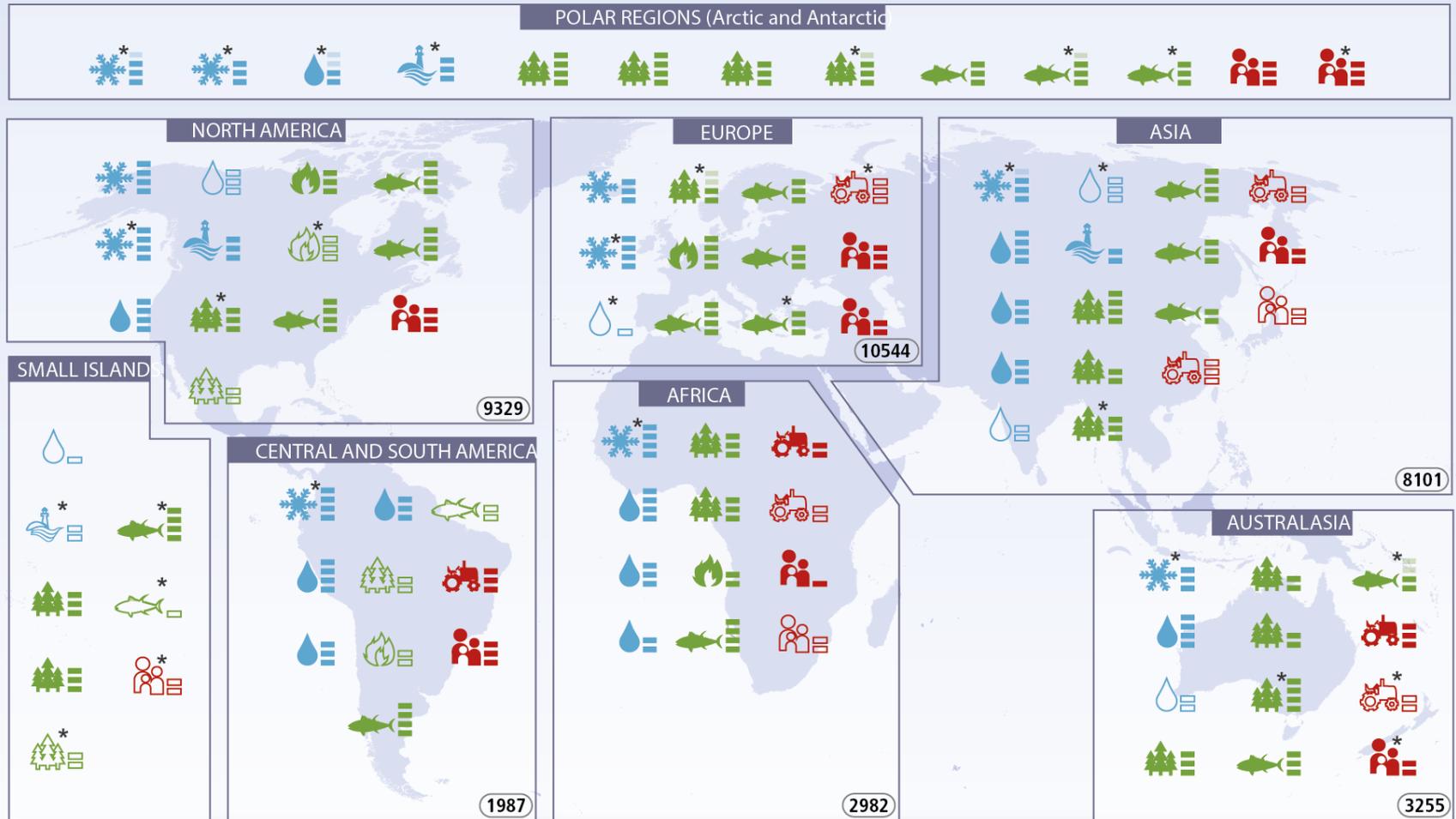
global mean sea level

Human influence
on the climate
system is clear

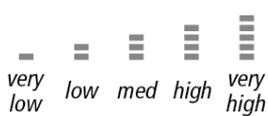
An underwater photograph of a coral reef. The water is a deep, murky green. The coral is mostly brown and white, indicating significant bleaching and mortality. A single, healthy-looking green coral polyp is visible in the center of the frame, standing out against the dead reef. The text is overlaid on the left side of the image.

OBSERVED IMPACTS
OF CLIMATE CHANGE
ARE WIDESPREAD
AND CONSEQUENTIAL

Widespread impacts attributed to climate change based on the available scientific literature since the AR4



Confidence in attribution to climate change

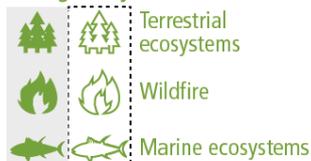


Observed impacts attributed to climate change for

Physical systems



Biological systems



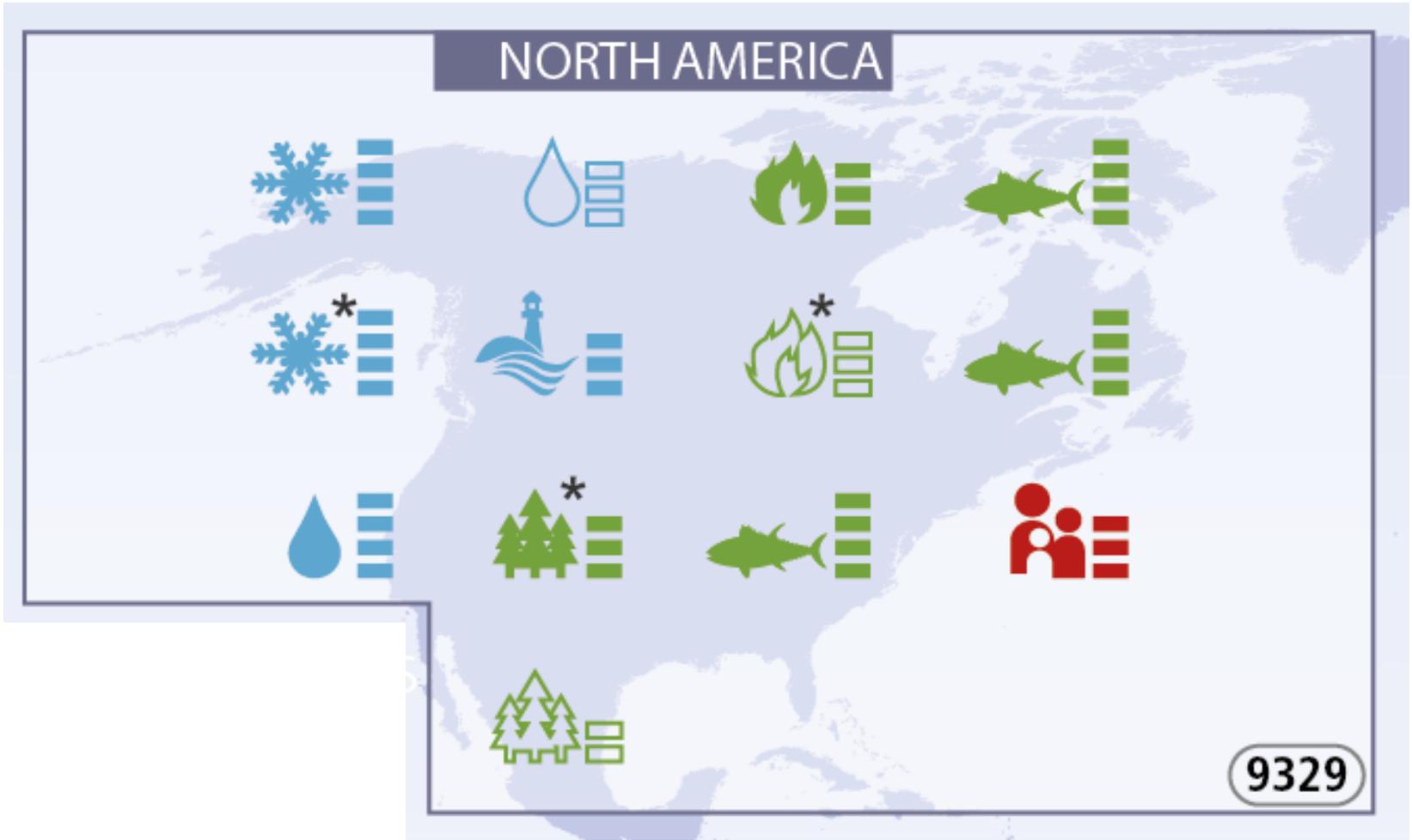
Human and managed systems



* Impacts identified based on availability of studies across a region

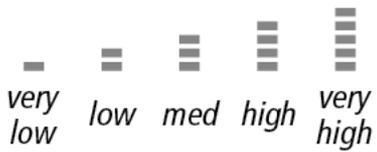
Outlined symbols = Minor contribution of climate change
 Filled symbols = Major contribution of climate change

NORTH AMERICA



9329

Confidence in attribution to climate change



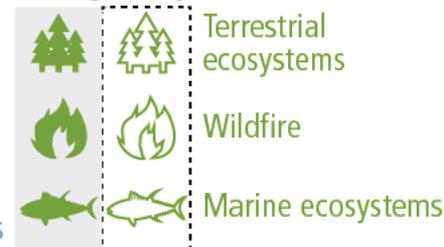
indicates confidence range

Observed impacts attributed to climate change for

Physical systems



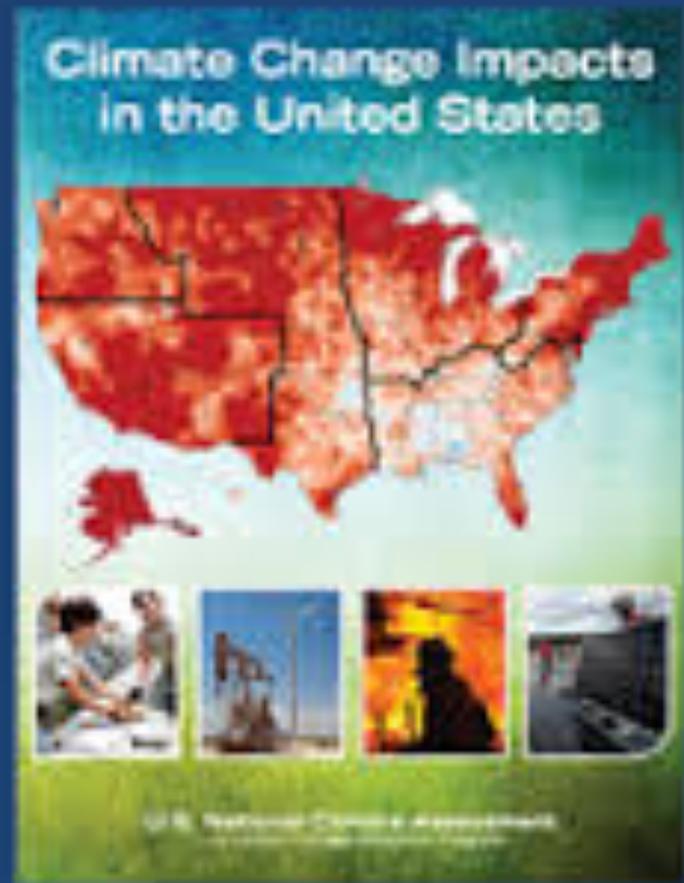
Biological systems



Human and managed systems



THE THIRD NATIONAL CLIMATE ASSESSMENT



A photograph of a city street completely flooded with water. The water is dark and reflects the surrounding buildings and sky. On the left, a multi-story brick building with many windows lines the street. On the right, another brick building with a modern glass and metal awning is visible. In the distance, a person in a red jacket is wading through the water, and a dark car is partially submerged. The sky is overcast and grey.

PEOPLE, SOCIETIES,
AND ECOSYSTEMS
AROUND THE WORLD

**VULNERABLE
AND EXPOSED**

IN DIFFERENT WAYS

ipcc

INTERGOVERNMENTAL PANEL ON climate change



INCREASING MAGNITUDES
OF WARMING INCREASE
THE LIKELIHOOD OF

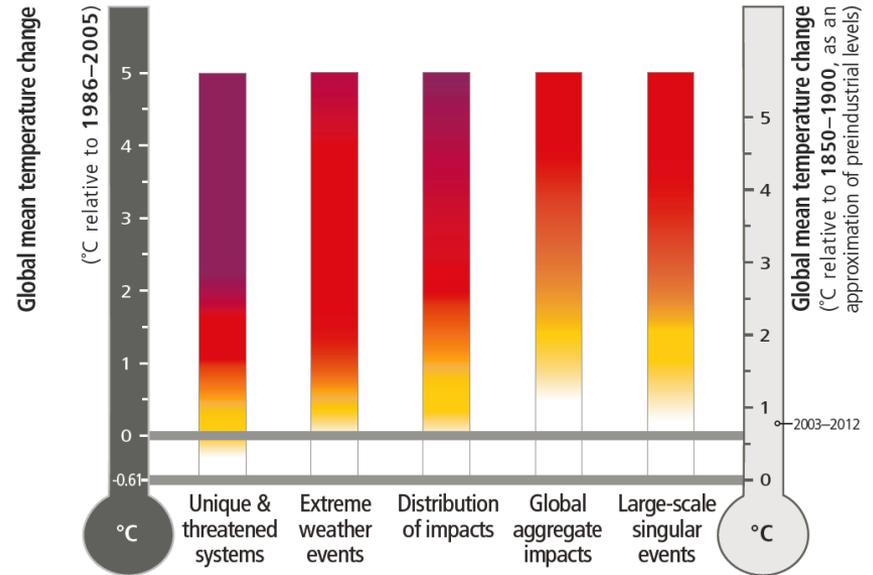
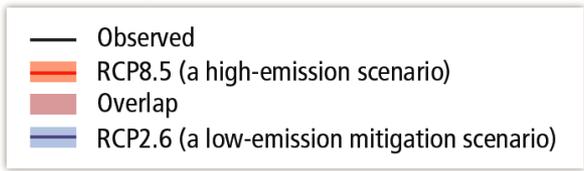
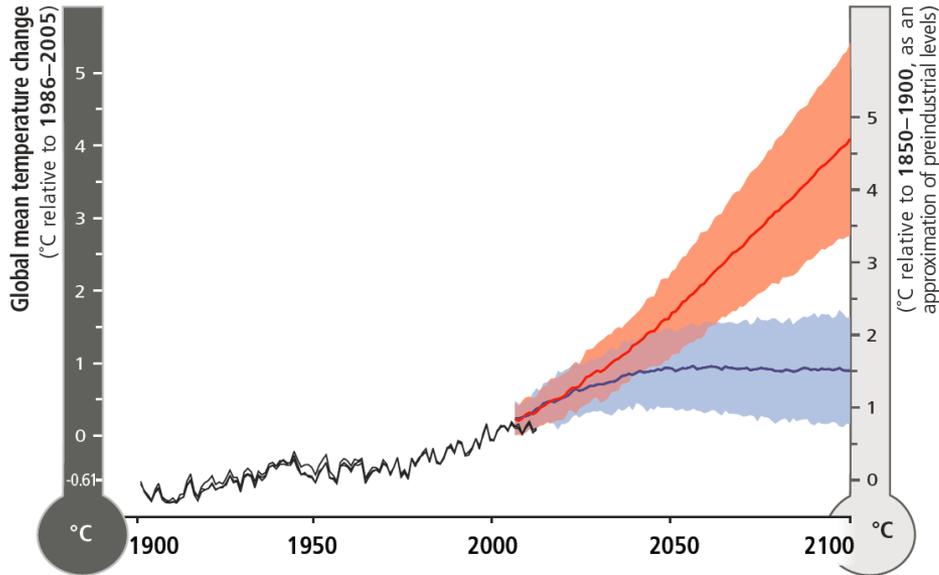
**SEVERE AND
PERVASIVE IMPACTS**



Risks of impacts

- Extreme Events
- Food, Water, & Human Security
- Health & Productivity
- Biodiversity & Heritage
- Tipping Points & Vicious-cycle Feedbacks

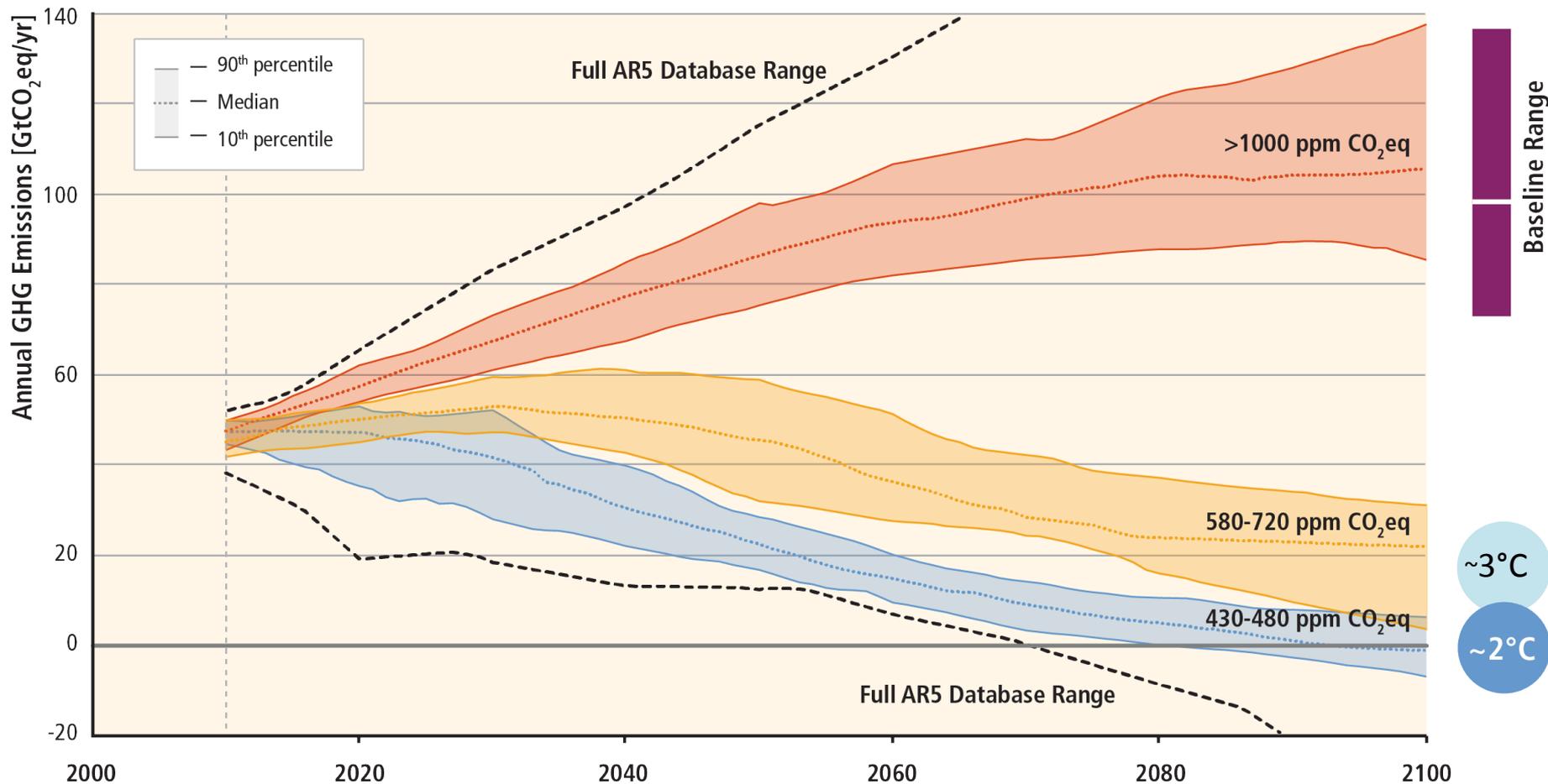
A global perspective on risks



Based on WGII Box SPM 1 Figure 1

Stabilizing temperature (eventually) requires zero net emissions – regardless of the warming limit chosen

– regardless of the warming limit chosen



Based on WGIII Figure SPM 4

Vulnerability & Exposure

- Vulnerability & exposure reduction
- Low-regrets strategies & actions
- Addressing multidimensional inequalities

Adaptation & Interactions with Mitigation

- Incremental & transformational adaptation
- Co-benefits, synergies, & trade-offs
- Context-specific adaptation
- Complementary actions

Risk

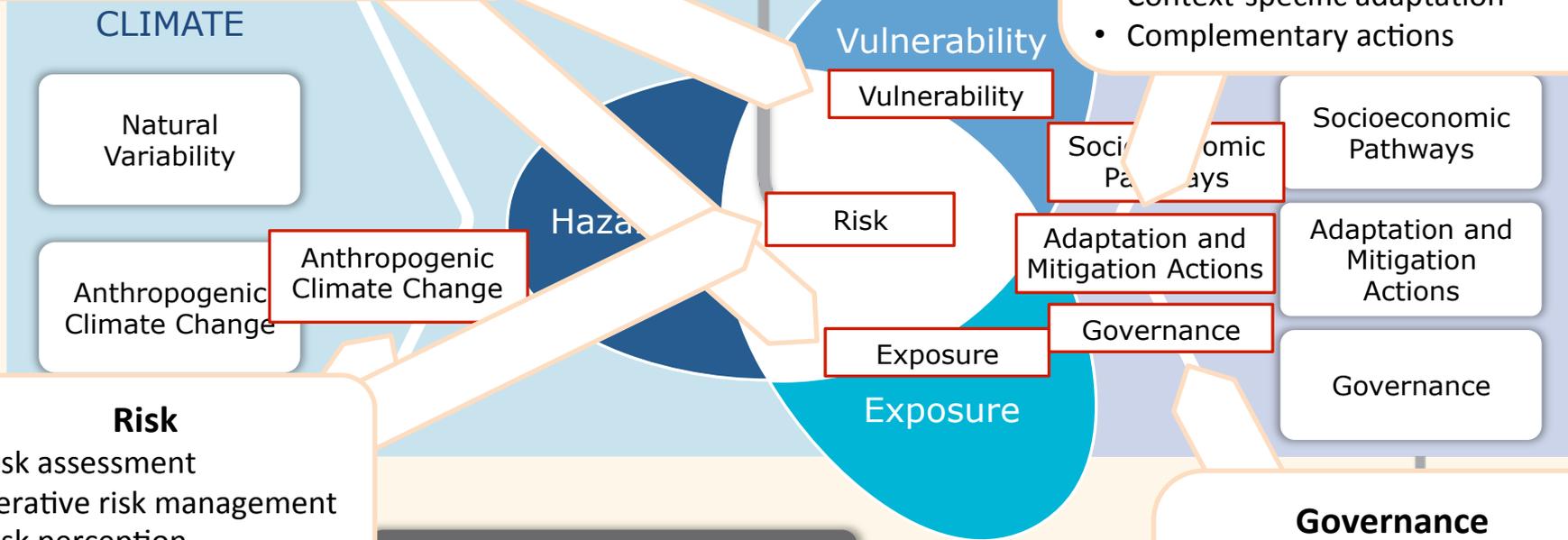
- Risk assessment
- Iterative risk management
- Risk perception

Governance

- Decision-making under uncertainty
- Learning, monitoring, & flexibility
- Coordination across scales

EMISSIONS and Land-use Change

IMPACTS



IAV Needs from IAM and ESM

- From ESMs
 - Hi resolution (both space and time) climate information
 - More on extremes
- From IAMs
 - Higher resolution information
 - Socio-economic drivers – SSP scenario “user guides”
 - More information on “key/emerging” interactions
 - Between people and physical systems
 - Between sectors (including GE and growth)
 - Between regions
 - Better understanding of catastrophies with cascading failures

A Few Examples of Multi-Sector Multi-Stressor Risks

- Drought in one region/sector on other regions/sectors
- Warming leading to more electricity demand and more cooling water but with less water available
- Large BioEnergy deployment causing increased competition for land, water, energy.
- Impacts of vegetation die back on other sectors

The End
Comments/Questions?

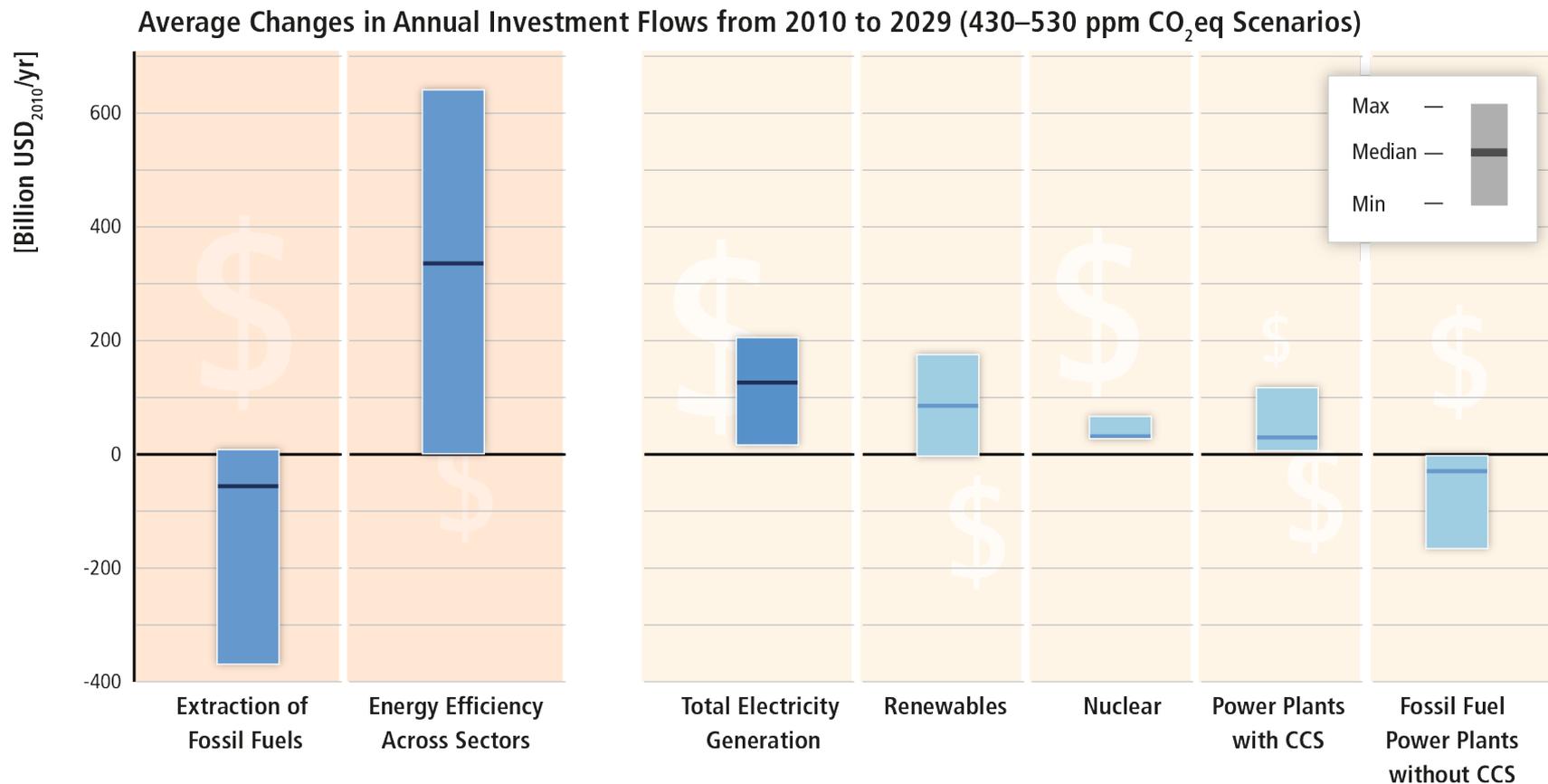


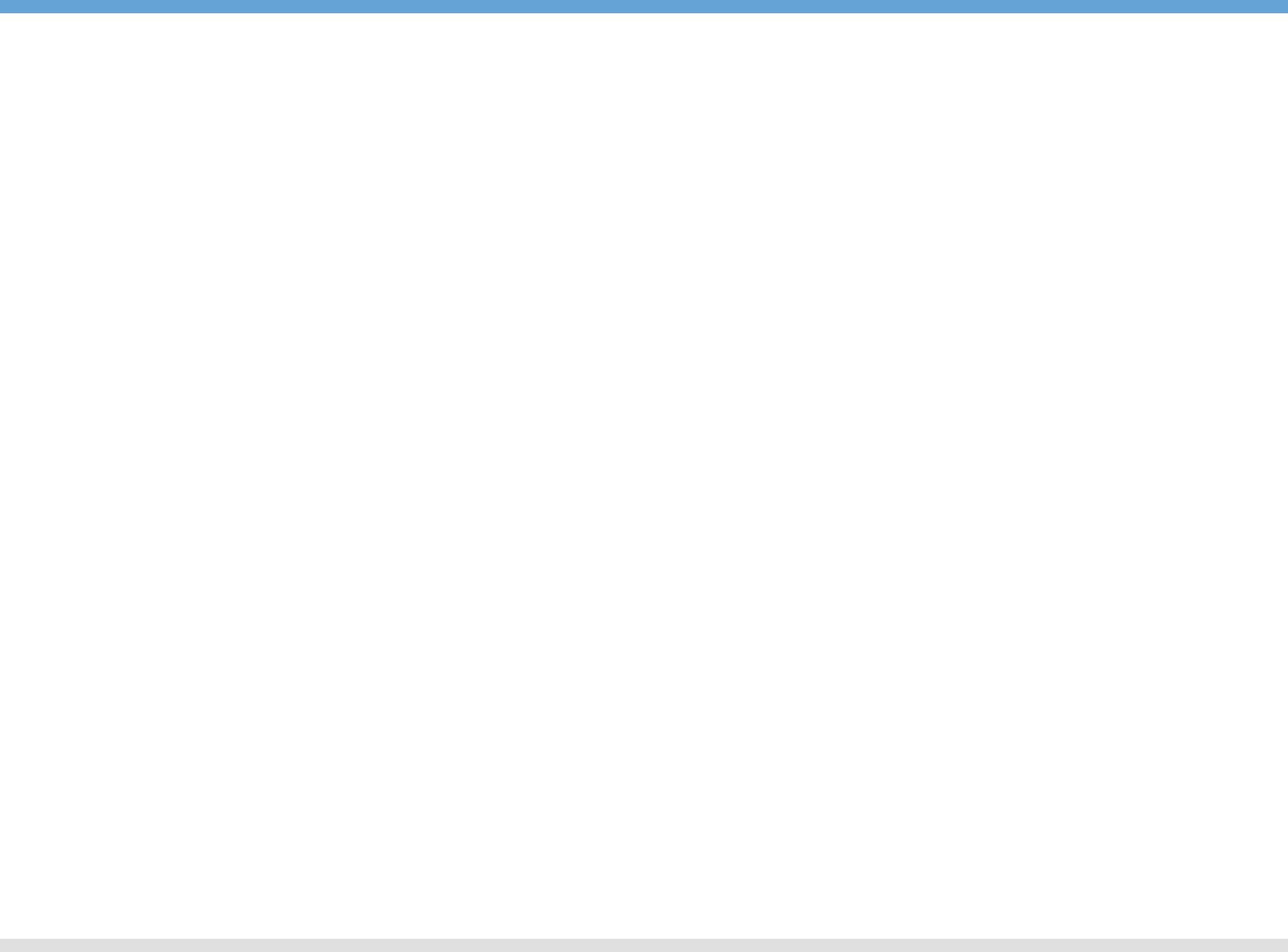
GHG EMISSIONS GROWTH
HAS ACCELERATED
DESPITE REDUCTION EFFORTS

EFFECTIVE CLIMATE CHANGE RESPONSES

A MORE VIBRANT WORLD

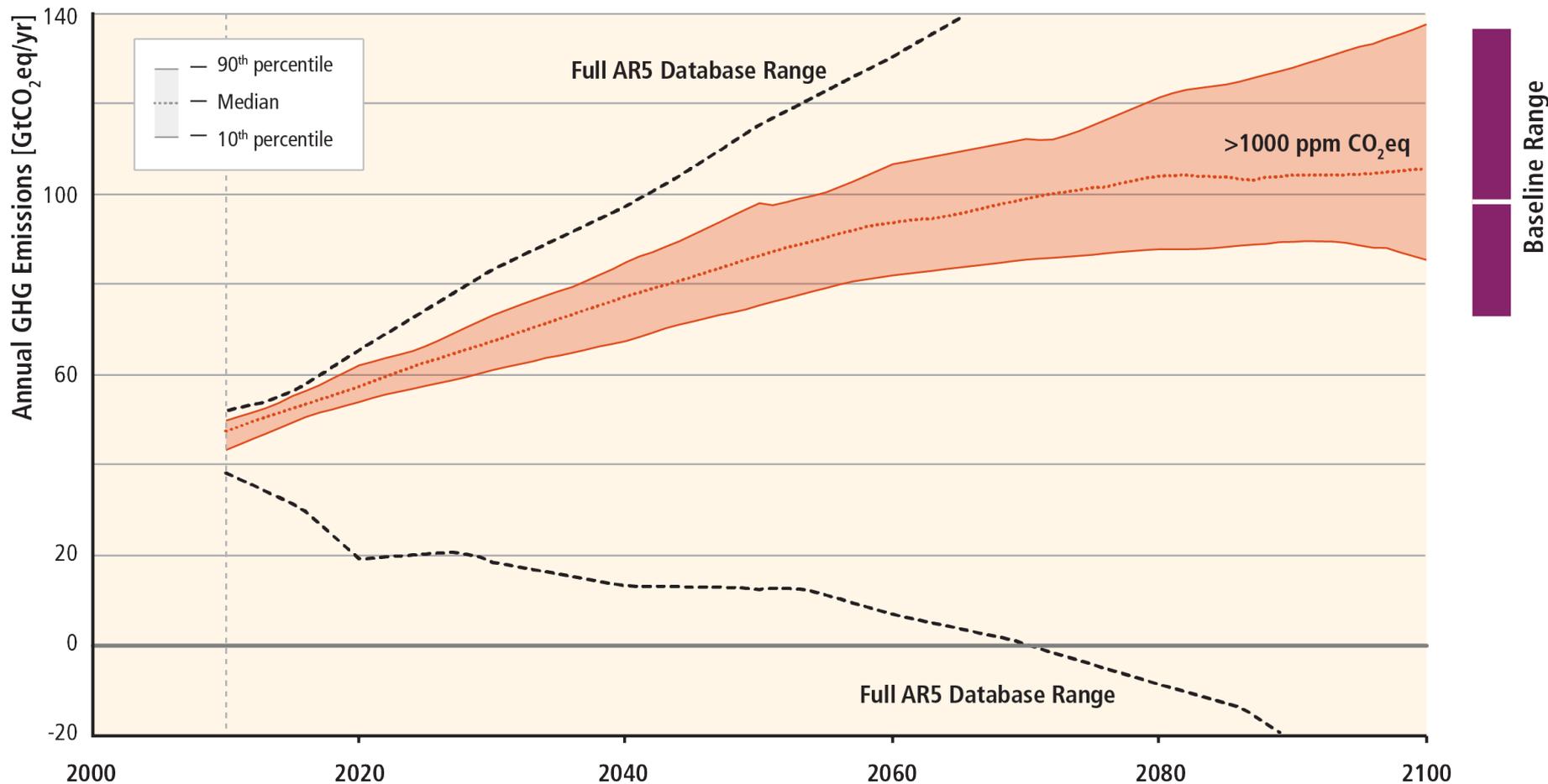
Investment needs = Investment opportunities





Stabilizing temperature (eventually) requires zero net emissions – regardless of the warming limit chosen

– regardless of the warming limit chosen



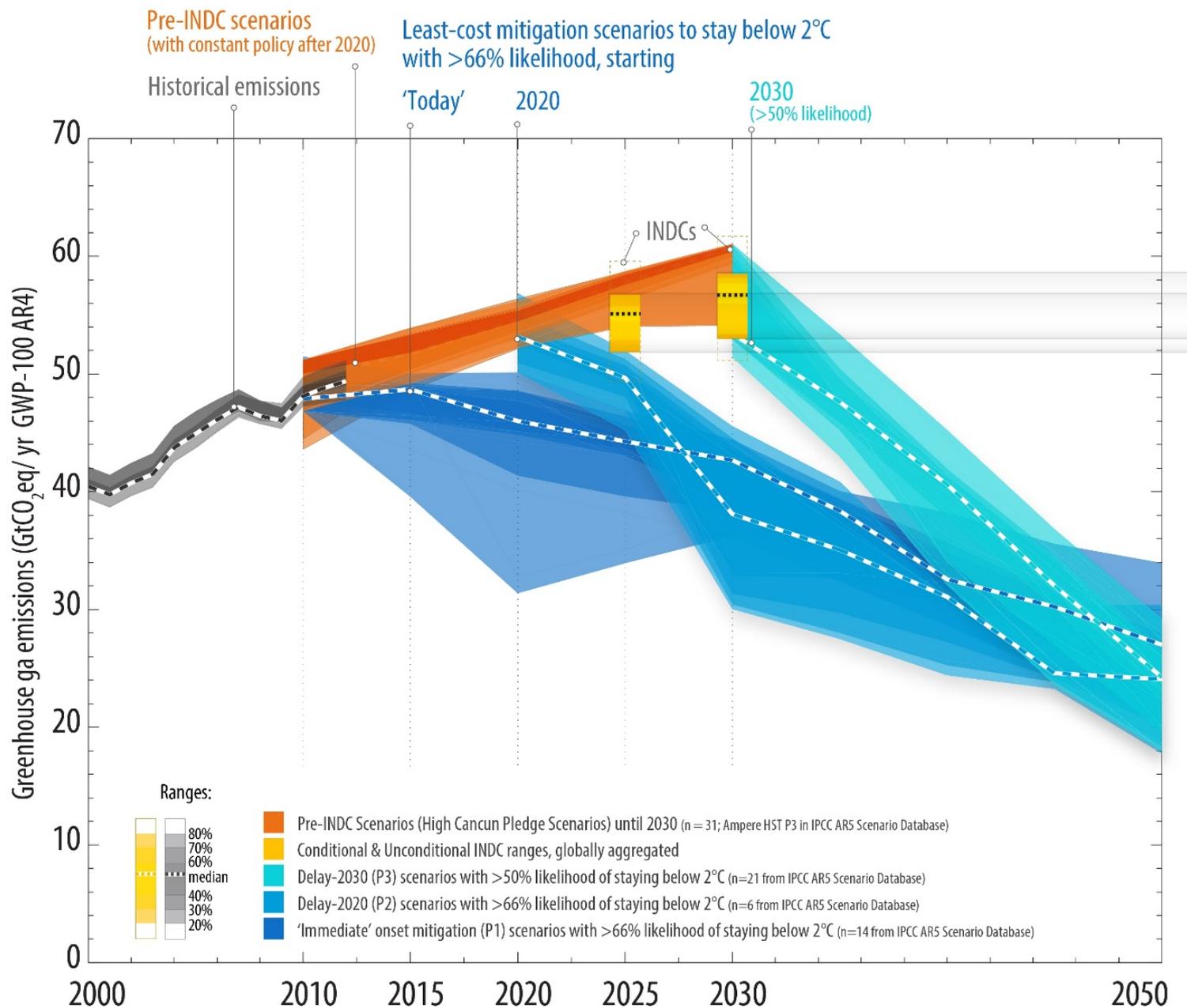
Based on WGIII Figure SPM 4



Four pillars for Paris

- Universal, binding agreement
- INDC from every country
- Finance and Technology
- Role for non-State Actors

INDCs: A first step or a last step?



THE SOLUTION SPACE

- Climate change is a challenge in managing risks
 - Adaptation is building momentum
 - Mitigation is building momentum
-
- Many opportunities for win-win solutions that help build robust economies and vibrant communities



THE PROBLEM SPACE



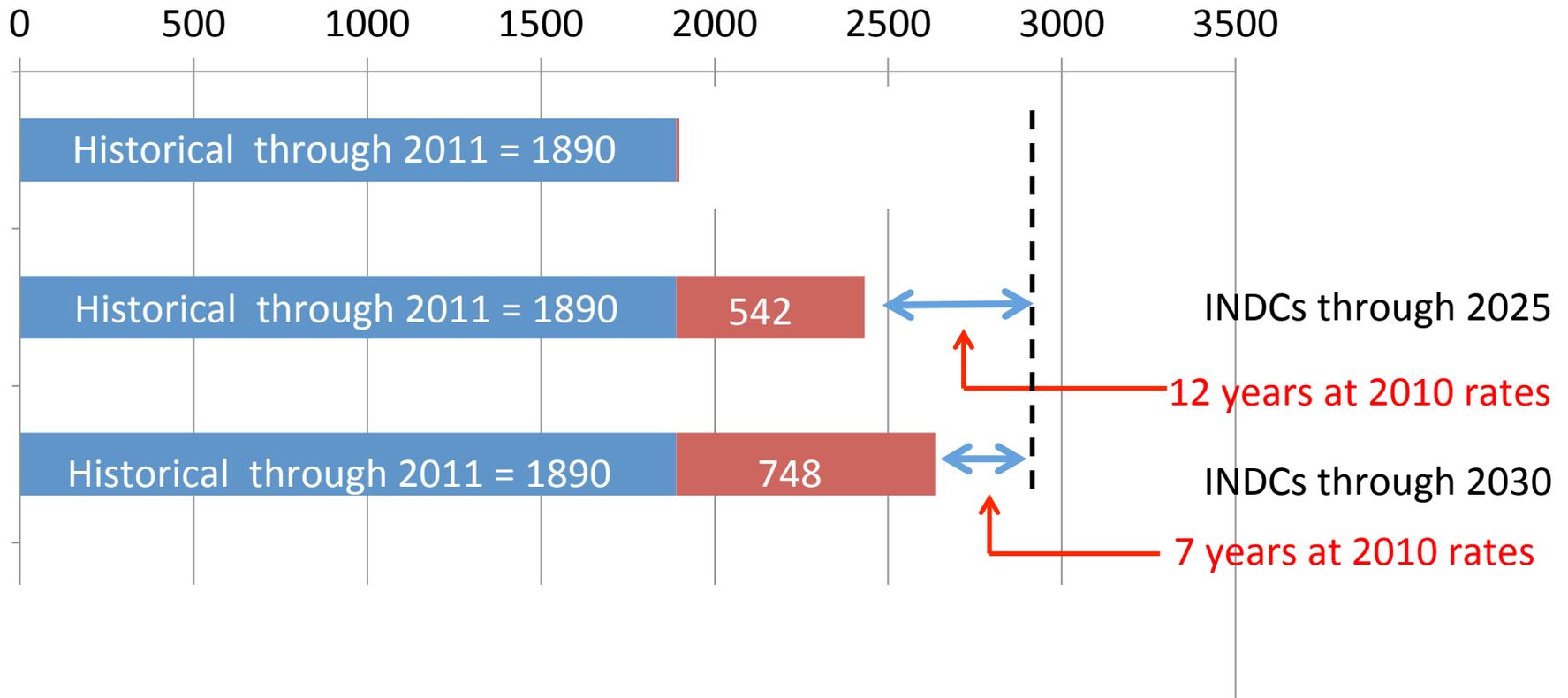


VULNERABILITY AND EXPOSURE

AROUND THE WORLD

INDCs: Budget mostly used by 2030

Cumulative emissions (GT CO₂ since 1870)



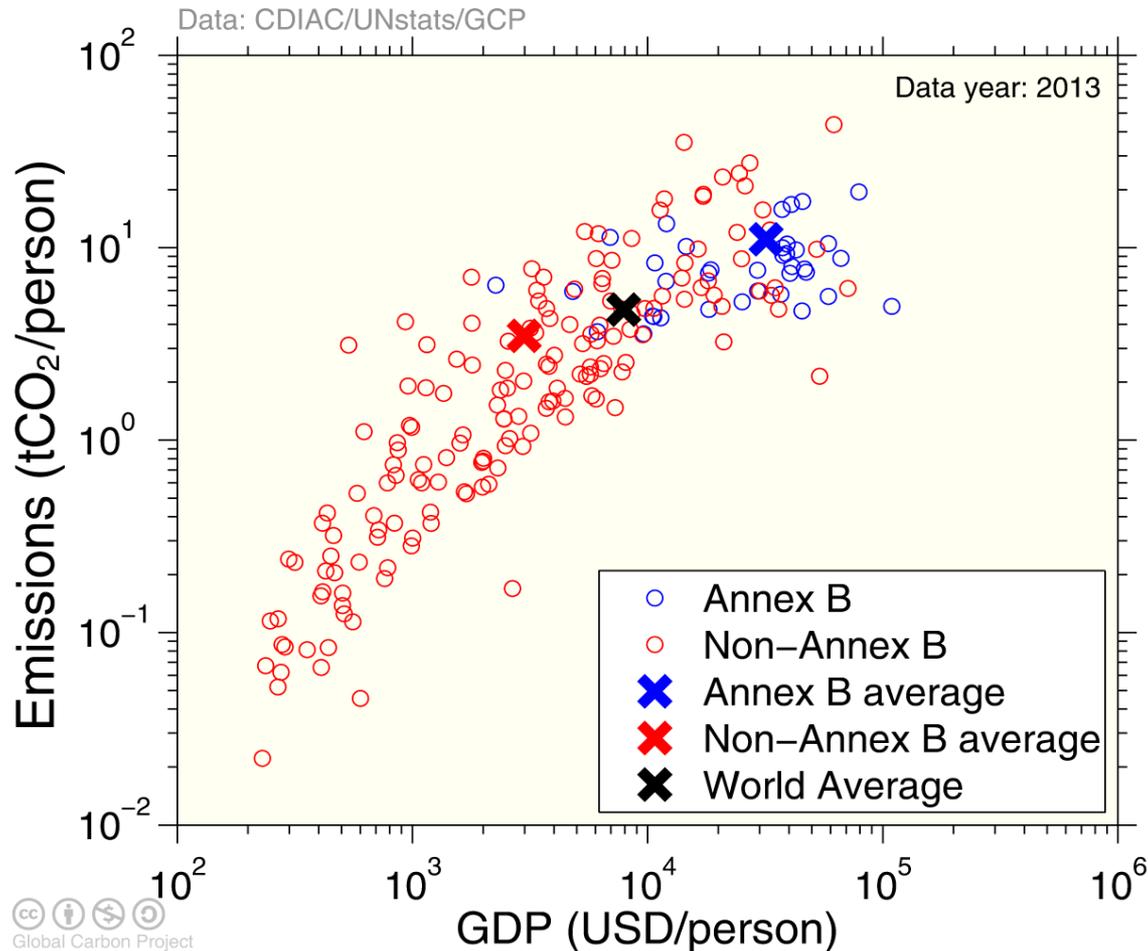


CLIMATE CHANGE

UNDERSTANDING,
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Annex B versus non-Annex B countries

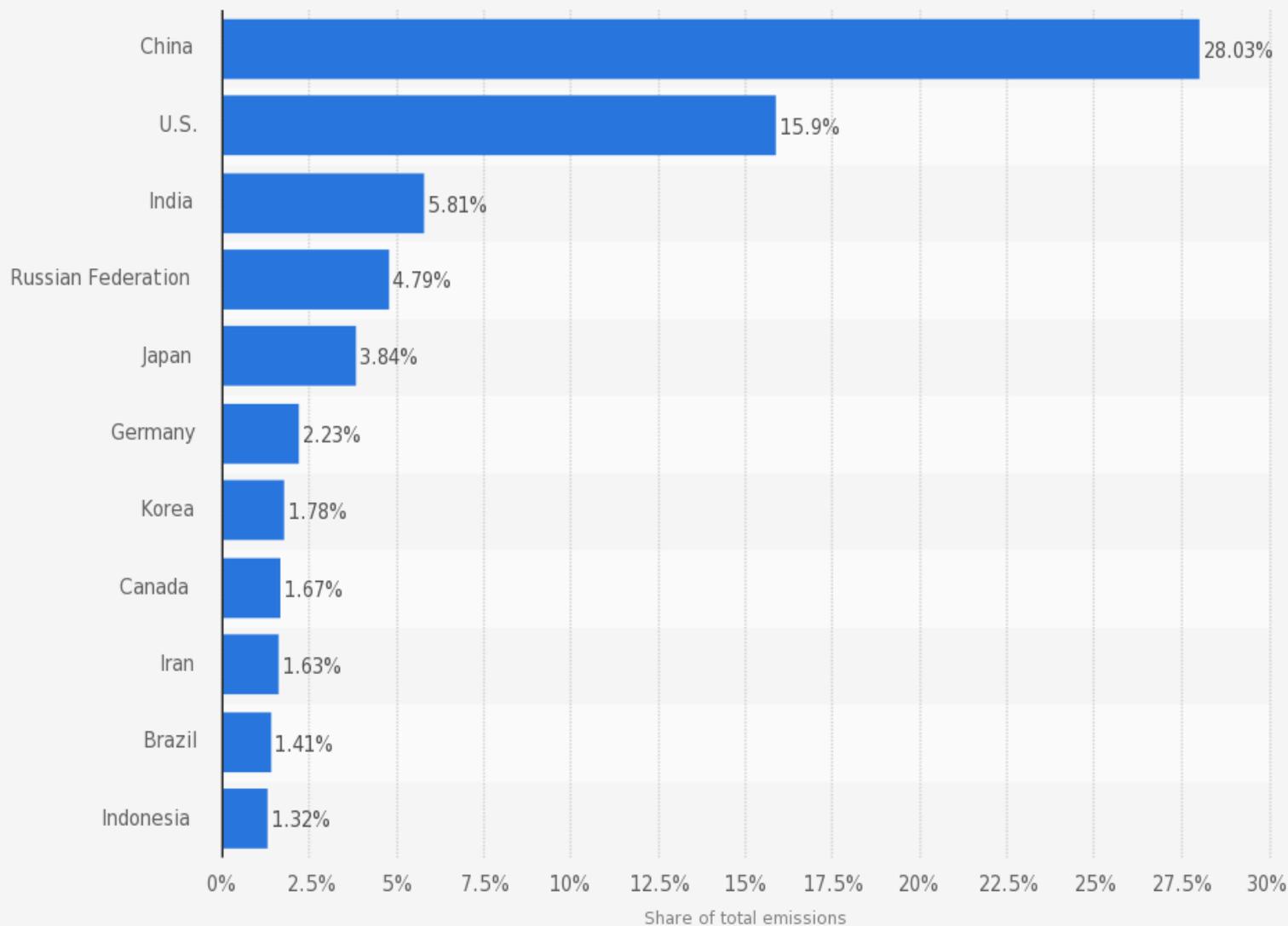
There is not a clear distinction between Annex B and non-Annex B countries based on economic activity per capita or emissions per capita



GDP is measured here in Market Exchange Rates

Source: [United Nations](#); [CDIAC](#); [Le Quéré et al 2015](#); [Global Carbon Budget 2015](#)

The largest producers of CO2 emissions worldwide in 2015, based on their share of global CO2 emissions



Source:
Germanwatch
© Statista 2015

Additional Information:
Worldwide

Per Capita Emissions for Top 10 Emitters

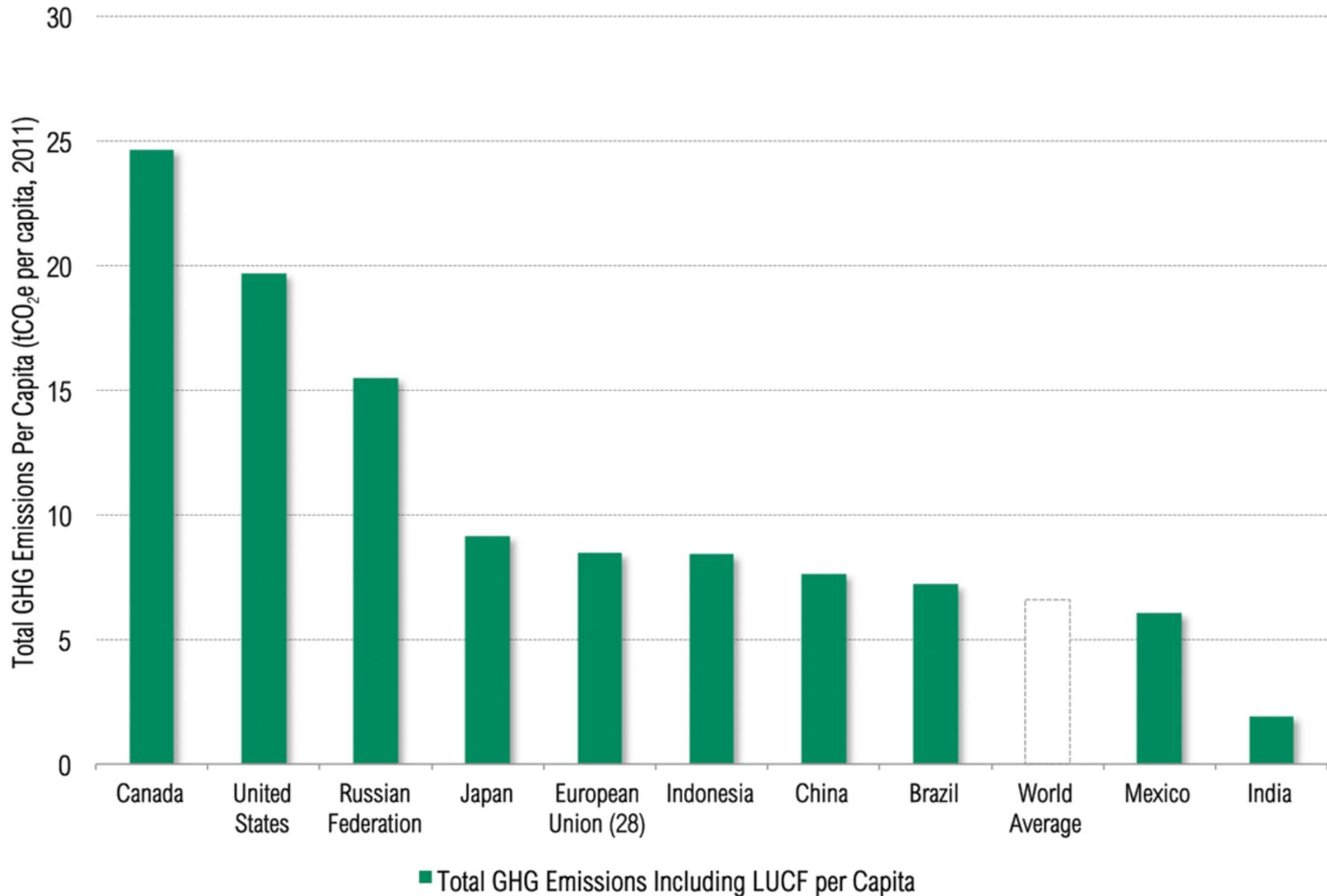
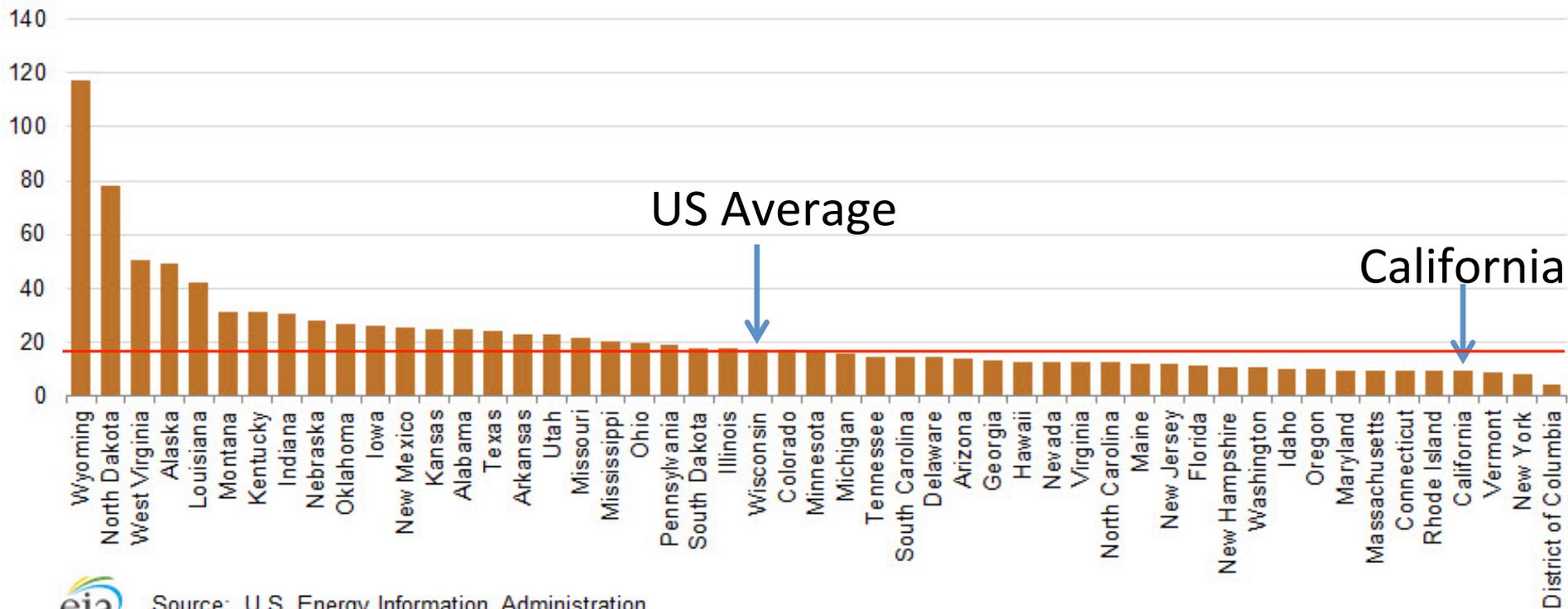


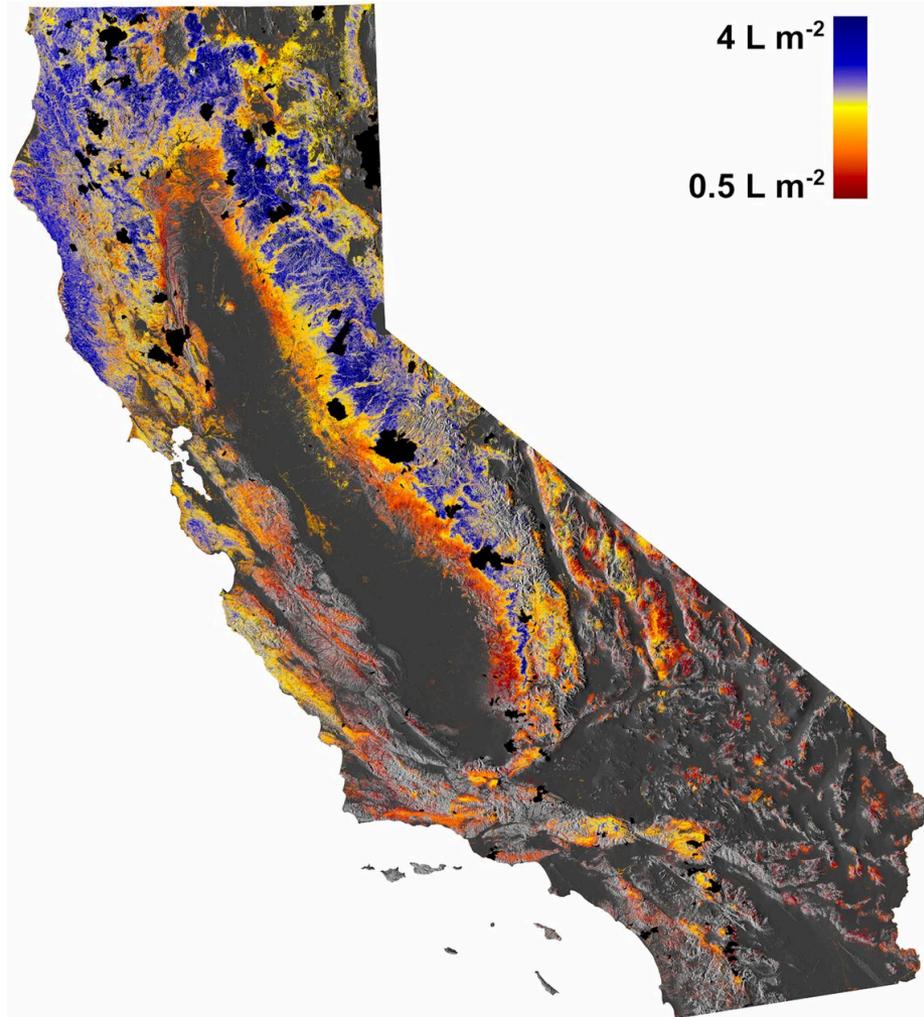
Figure 2. Per-capita energy-related carbon dioxide emissions by state, 2013

metric tons carbon dioxide per person

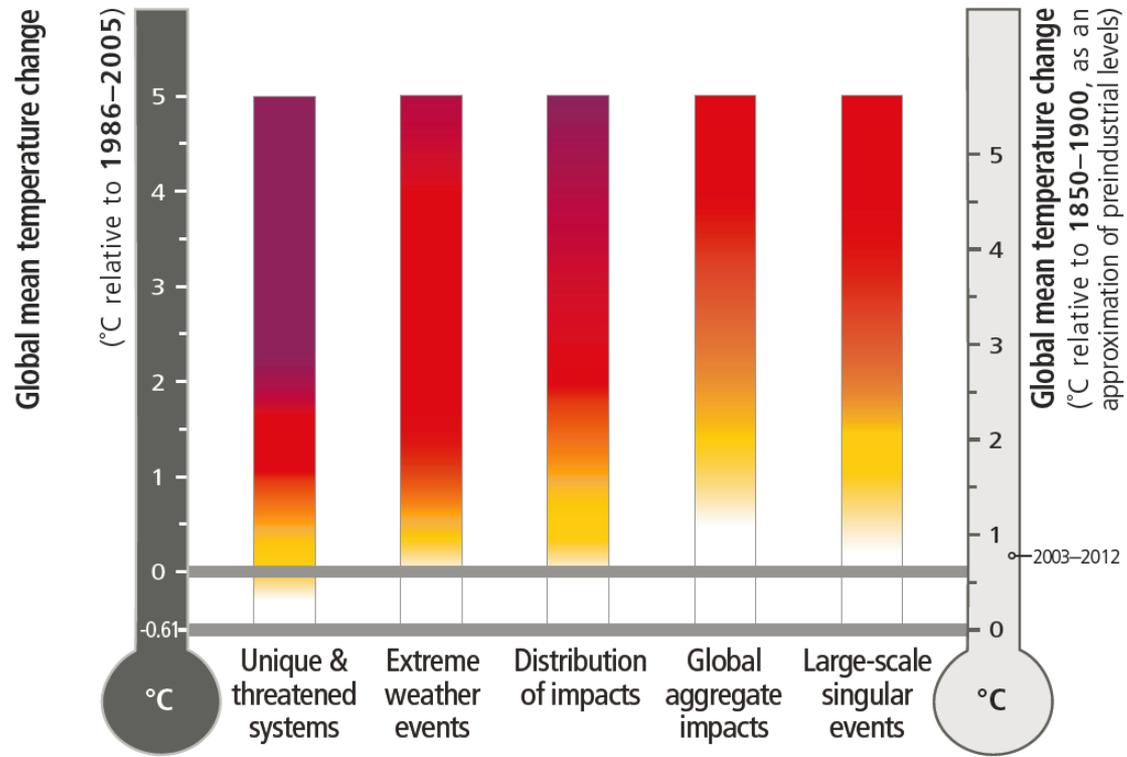


Source: U.S. Energy Information Administration.

Forest canopy water content in August 2015

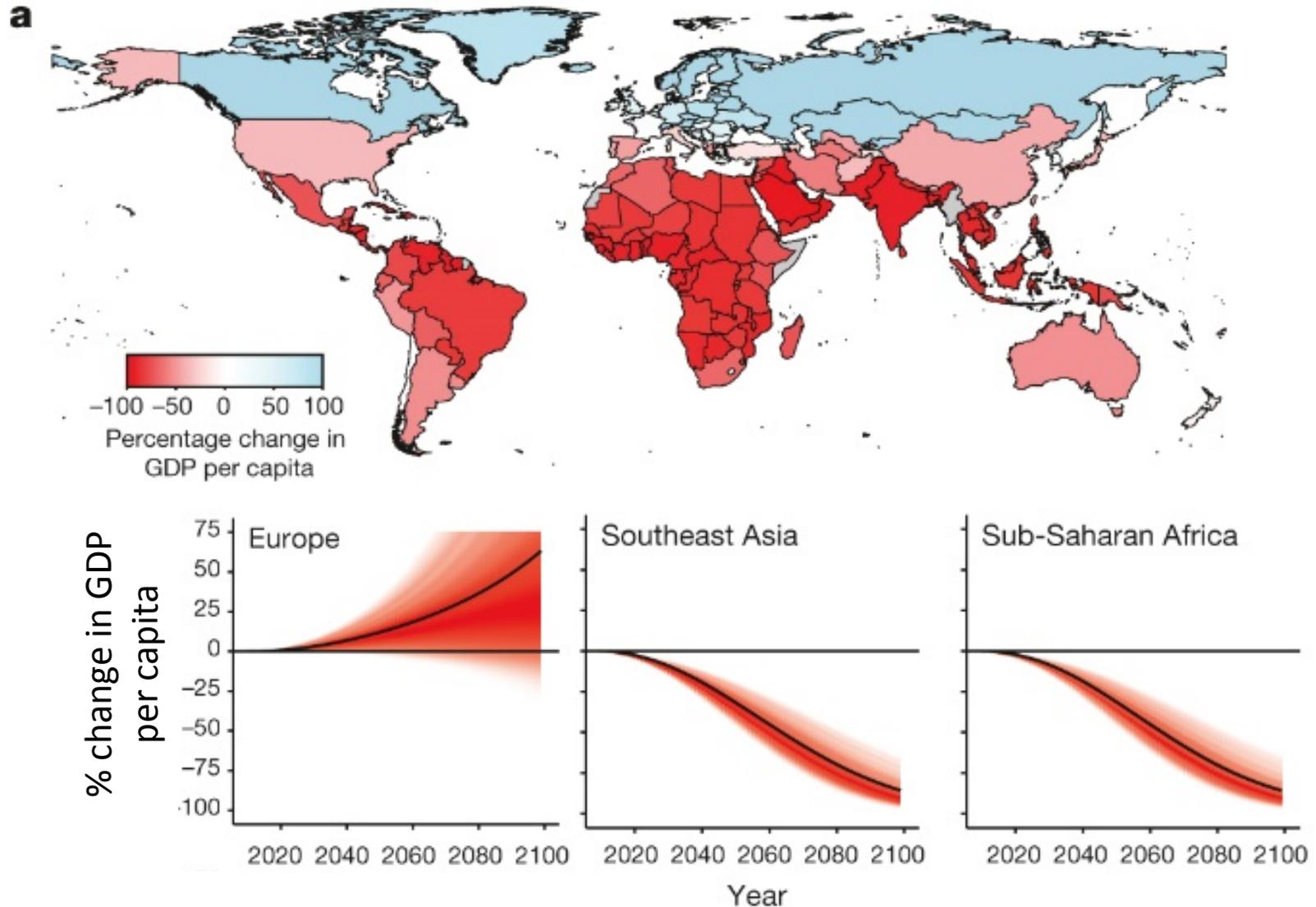


Gregory P. Asner et al. PNAS 2016;113:E249-E255



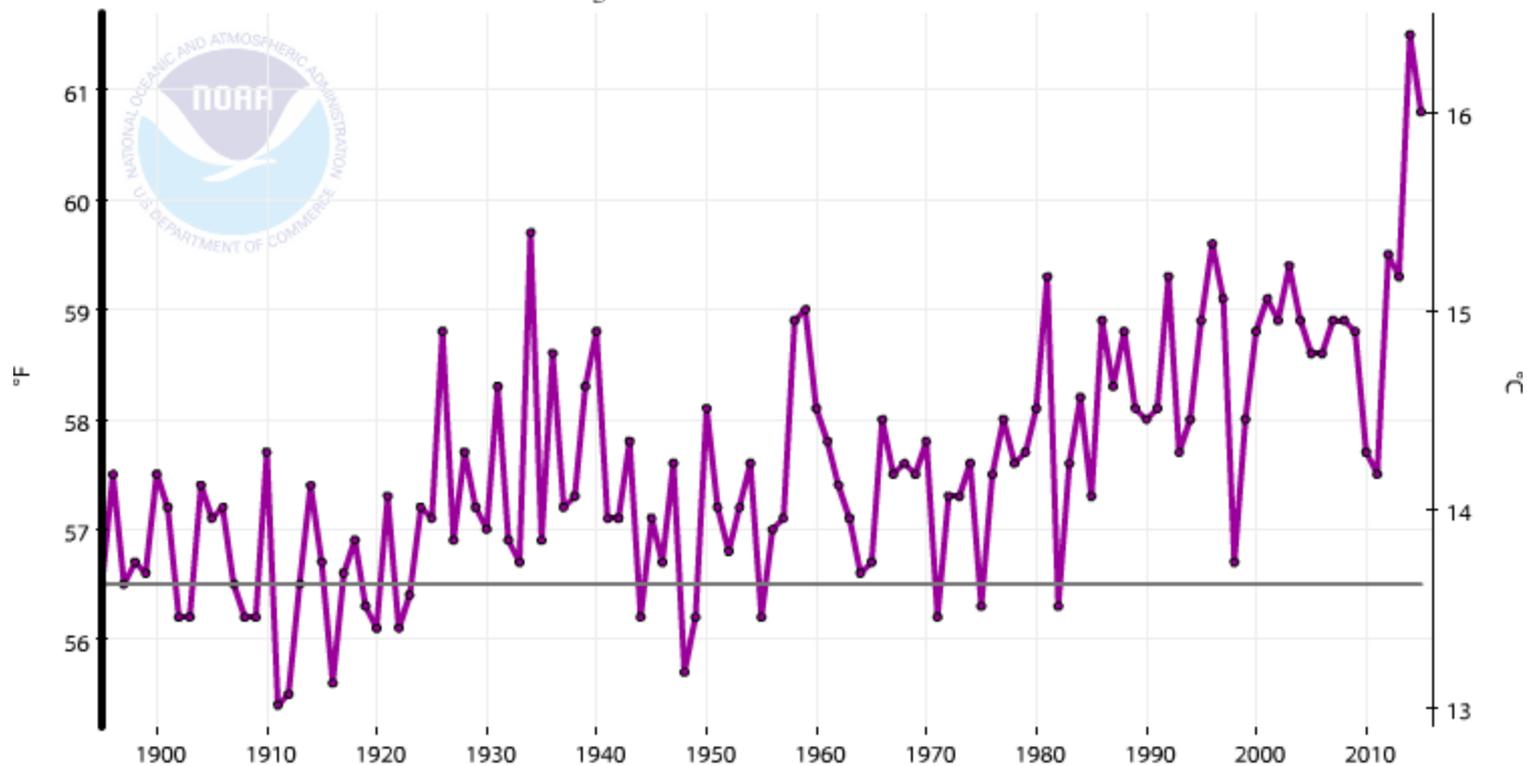
Based on WGII
Box SPM 1 Figure 1

Projected effect of temperature changes on regional economies

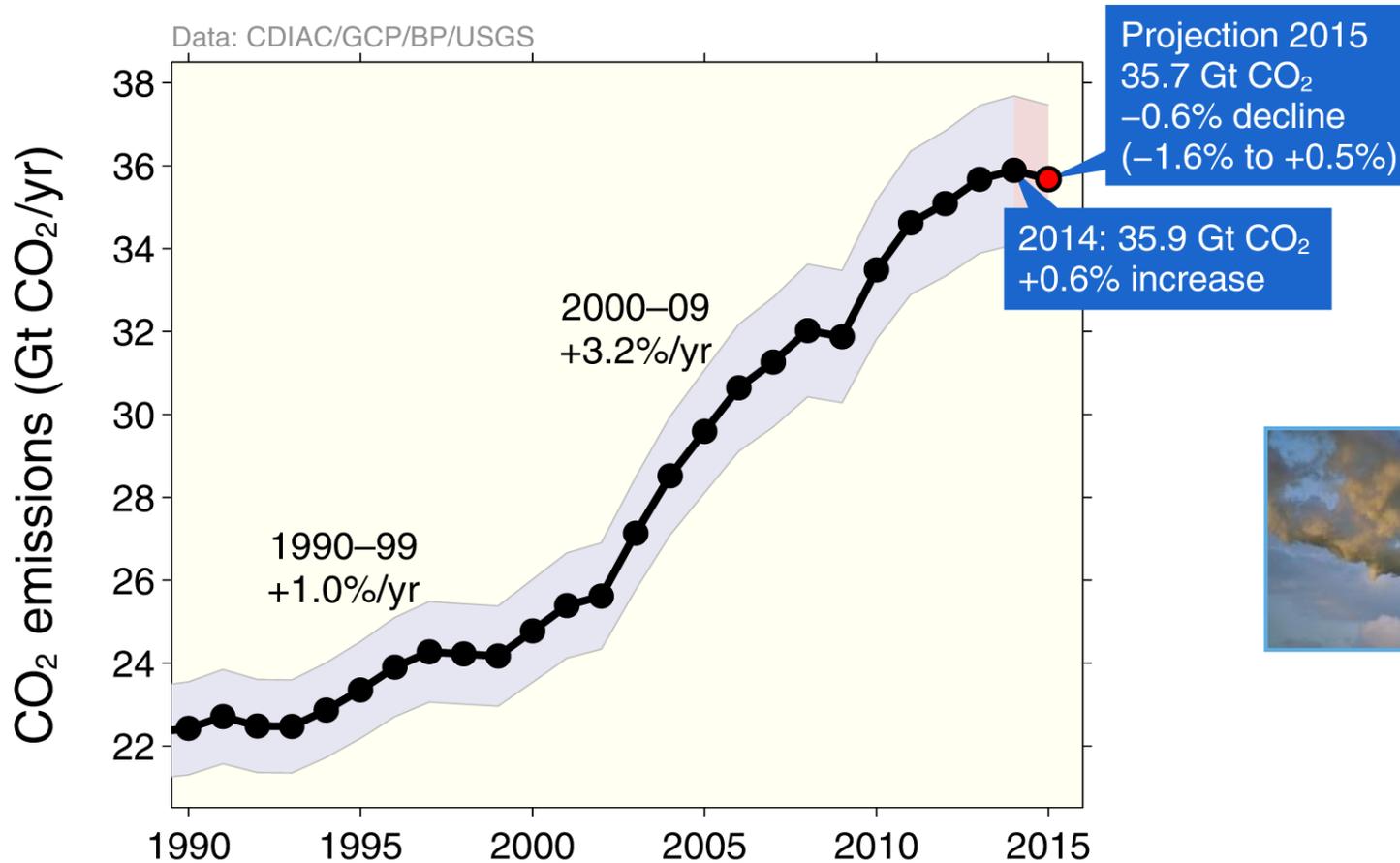


California, Average Temperature, January-December

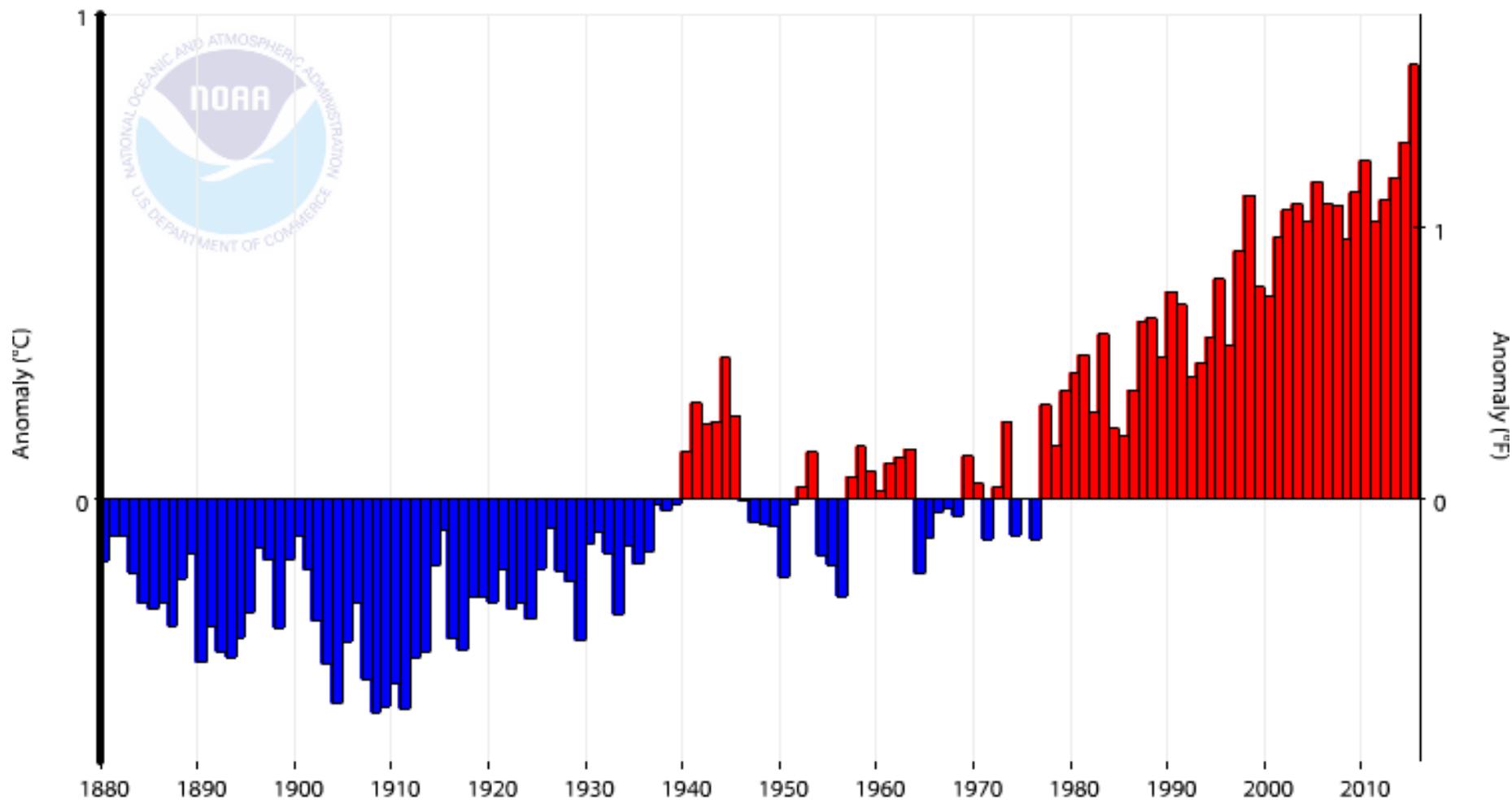
— 1901-1920 Avg: 56.5°F —●— Avg Temperature



Emissions from fossil fuel use and industry



Global Land and Ocean Temperature Anomalies, January-December



States of the Antarctic Ice Sheet after 10,000 years

