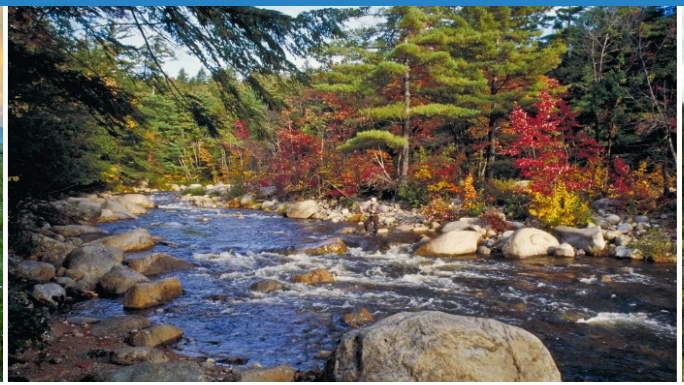
United States Department of Agriculture
Northern Forests Climate Hub

Climate Change FAQs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Frequently asked questions about:

- Climate change
  - Observations
  - Mechanisms
- Uncertainty
  - Scenarios and models
  - Uncertainty in predictions
- Ecosystem response to climate change
  - Potential benefits to system
  - Increases in stress

Isn't there still a scientific debate about climate change?

Debate?

Intergovernmental Panel on Climate Change (2007, 2010, 2013, 2018)

- Evidence for climate change is "unequivocal"
- It is "extremely likely" that humans are main cause since 1950
  - *"Human influence on the climate system is clear."*
- Future changes depend partly on human actions

18 National Academies have endorsed the consensus position of the IPCC on climate change

- National Academy of Sciences (USA)
- Royal Society of Canada

Debate?

See: Oreskes et al. 2004, Doran et al. 2009, Anderegg et al. 2010, Cook et al. 2013, Verheggen et al. 2014, Stenhouse et al. 2014, Carlton 2015

http://sks.to/consensus

Is there still a debate?

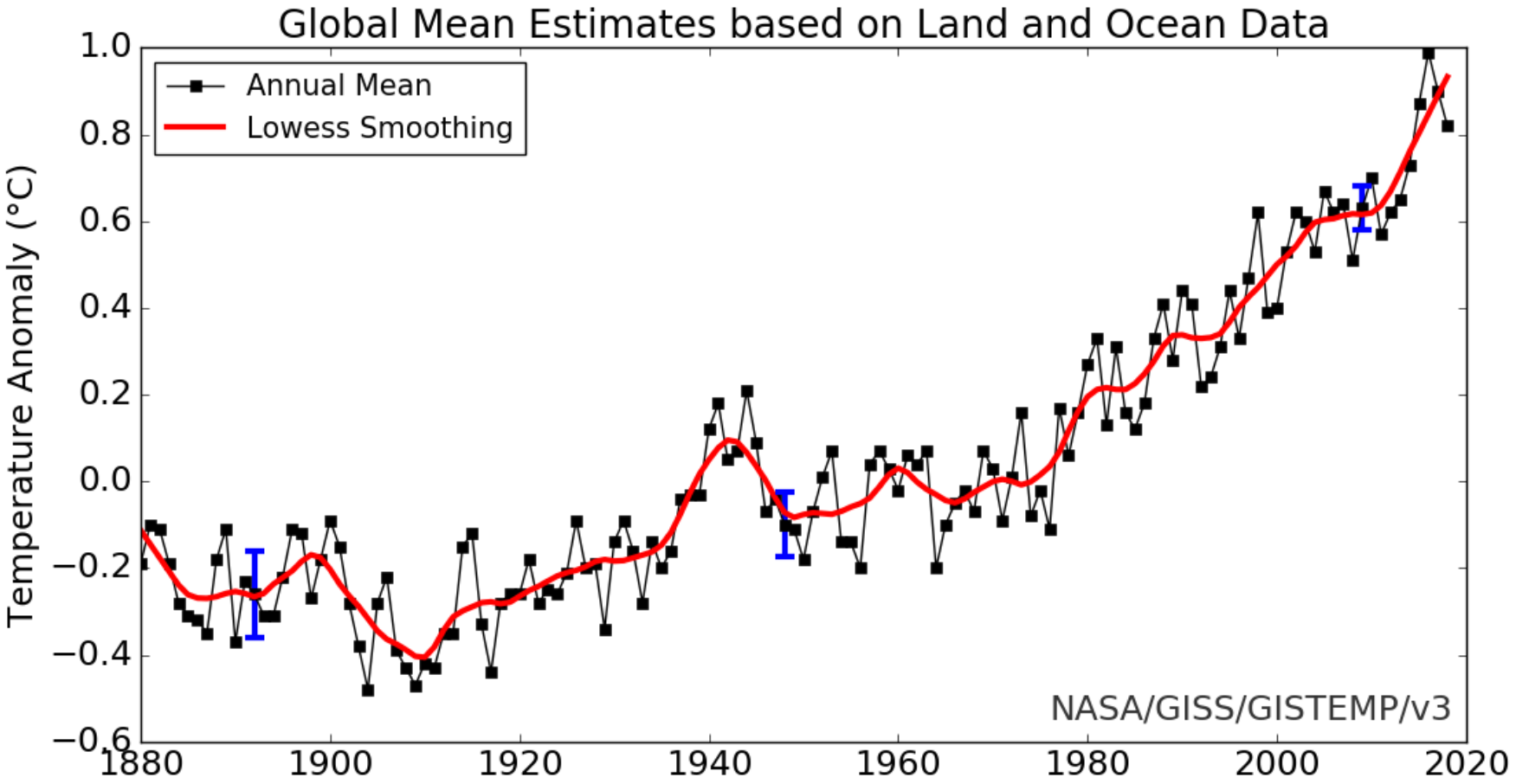
- No scientific debate on “if”.
- Current scientific debate revolves around how much, how fast, and feedback mechanisms.
- Virtually all climate scientists agree humans are a driver.

A practical risk assessment may be a better strategy than belief.

Is it climate change or global warming?

Climate change or global warming?

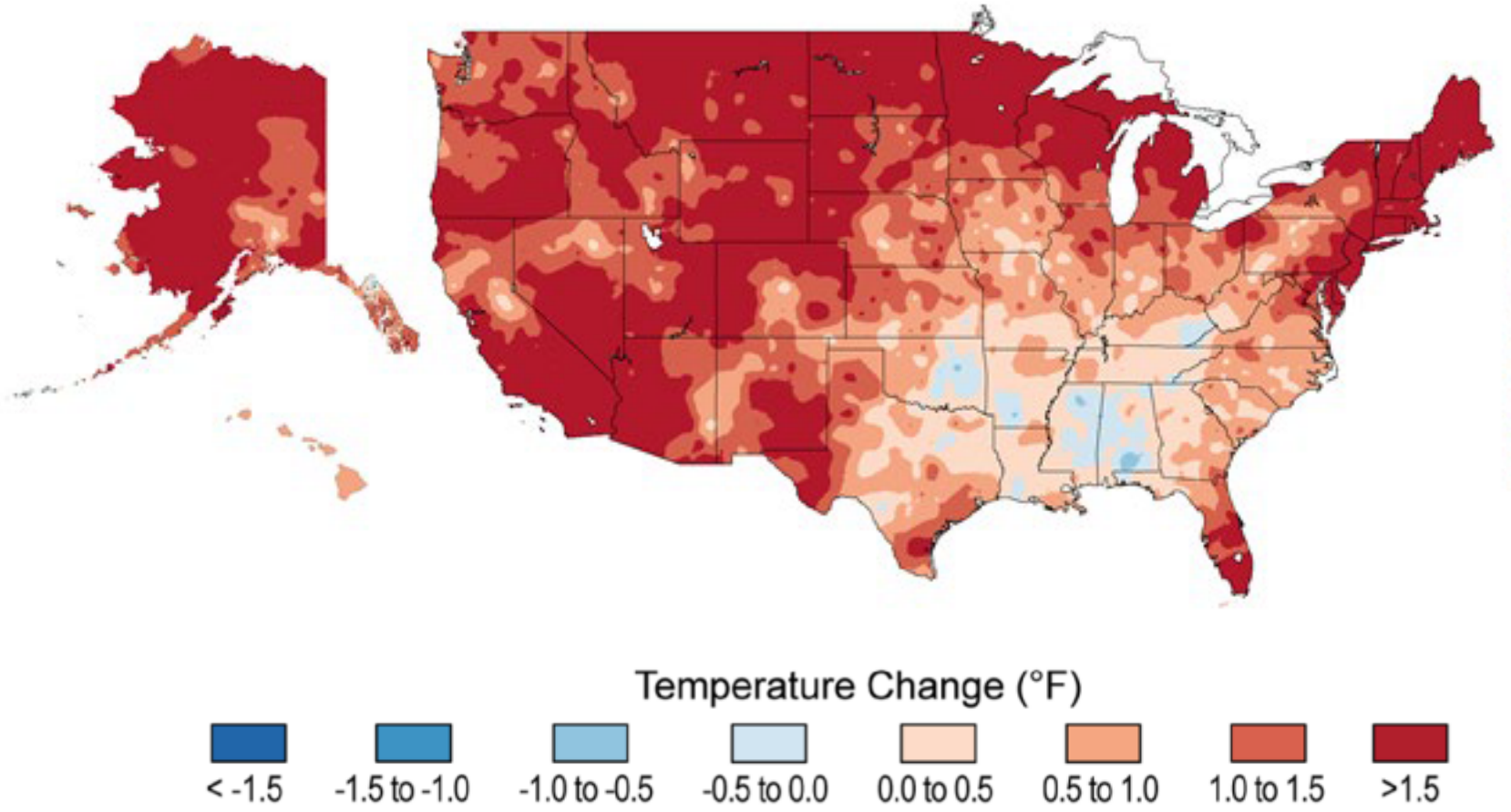
The average global surface temperature has risen 1.8°F over the past 115 years



IPCC 2007, 2013, 2018; NCA 2018; figure courtesy of NASA GISS

Climate change or global warming?

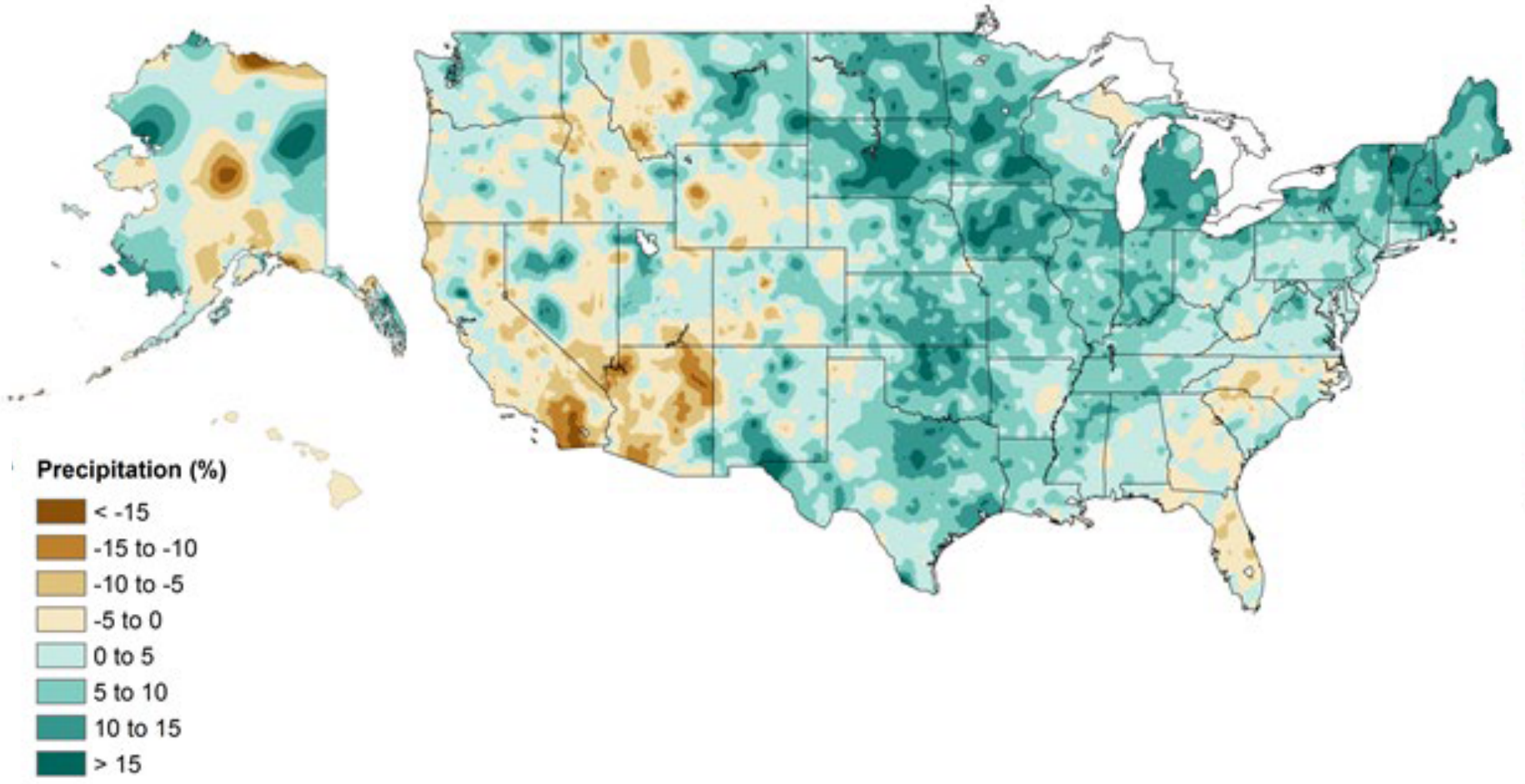
Contiguous US: 1986-2016 departure from 1901-1960 average



NCA 2018

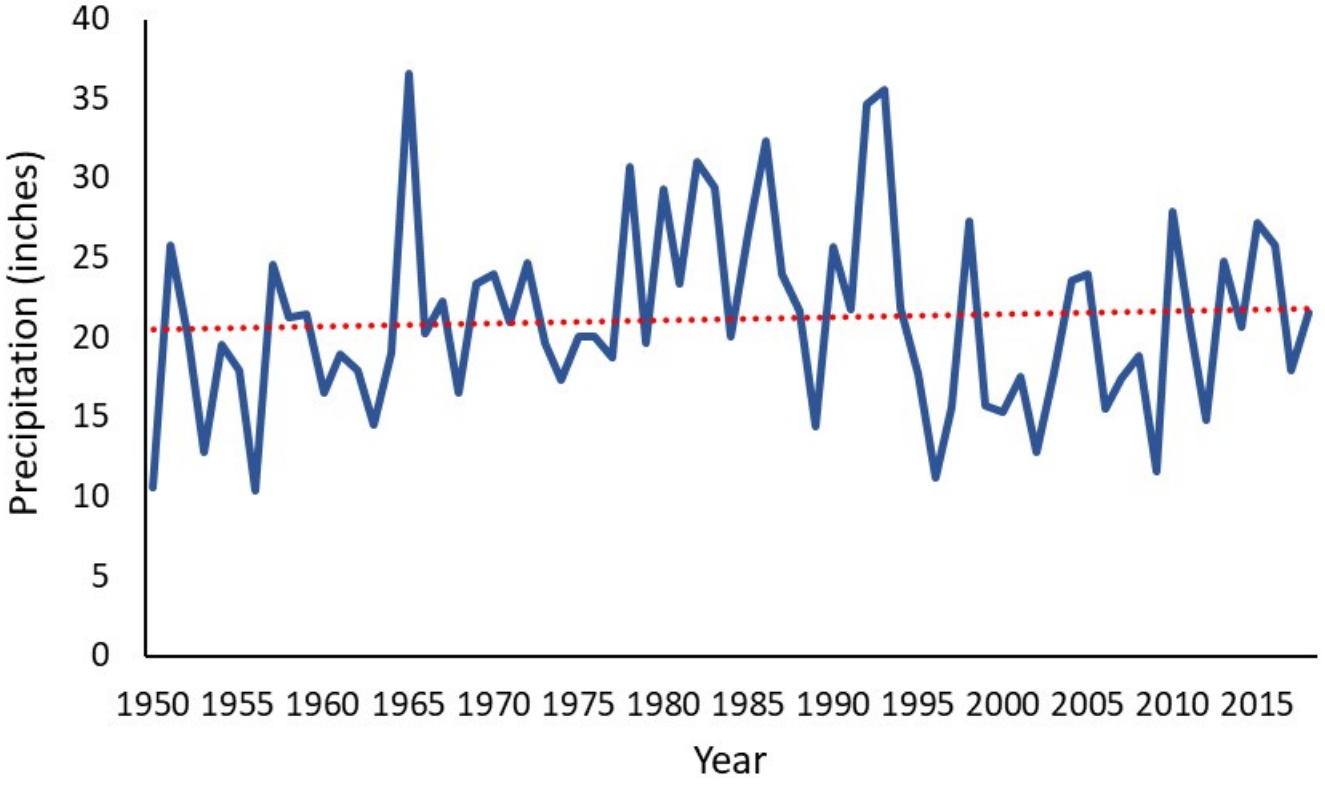
Climate change or global warming?

Contiguous US: 1986-2015 departure from 1901-1960 average



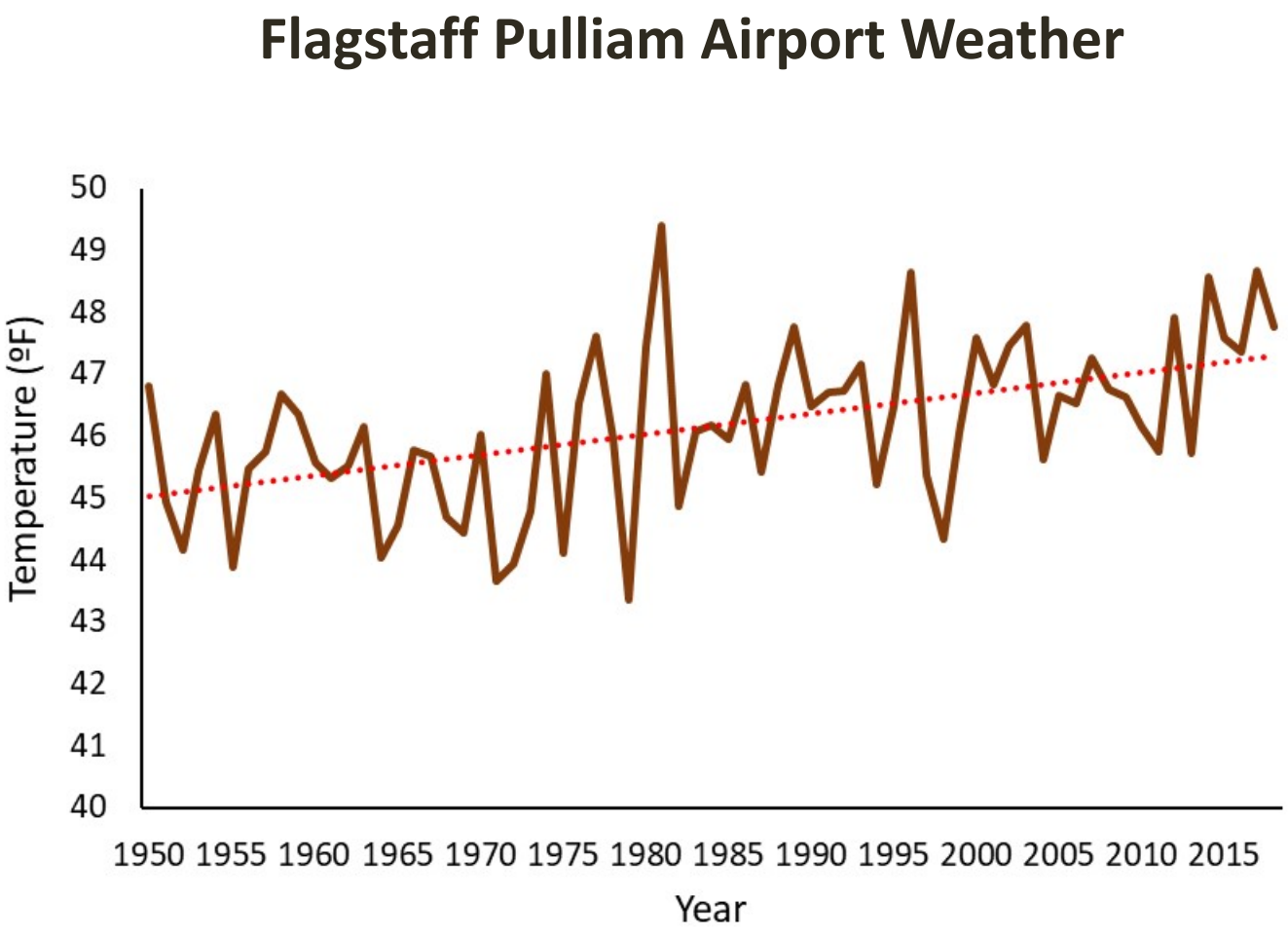
NCA 2018

Flagstaff Pulliam Airport Weather



“Annual average temperature over the contiguous United States has increased by 1.2ºF (0.7°C) over the last few decades and by 1.8°F (1°C) relative to the beginning of the last century.”

Fourth National Climate Assessment 2018



Flagstaff, Arizona

Elevation: 7,000 ft

Mean Annual Temperature: 46.3˚F

Weather Data: www.wrcc.dri.edu
Gallup Photo: http://www.alltrails.com/api/alltrails/photos/11321630/image?size=extra_large&api_key=3p0t5s6b5g4g0e8k3c1j3w7y5c3m4t8i
Prescott Photo> http://www.prescottarizonabusinessdirectory.com/images/fort-whipple-prescott-va.jpg

Gallup, New Mexico

Elevation: 6,500 ft

Mean Annual Temperature: 48.7˚ F

+2.4˚ F

~ RCP 4.5

Prescott, Arizona

Elevation: 5,400 ft

Mean Annual Temperature: 54.8˚ F

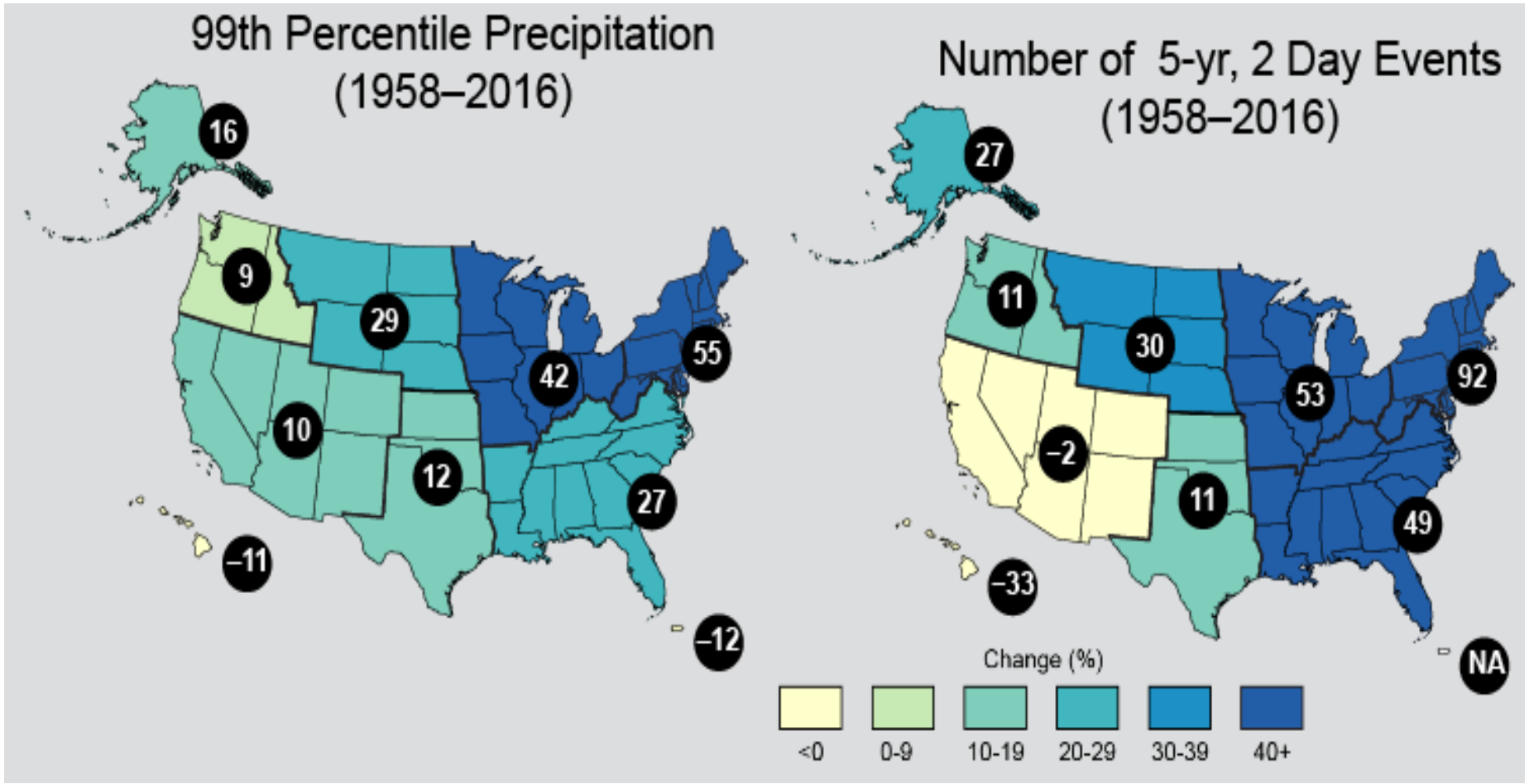
+8.5˚ F

~ RCP 8.5

Climate change or global warming?

Extreme precipitation events have gotten:

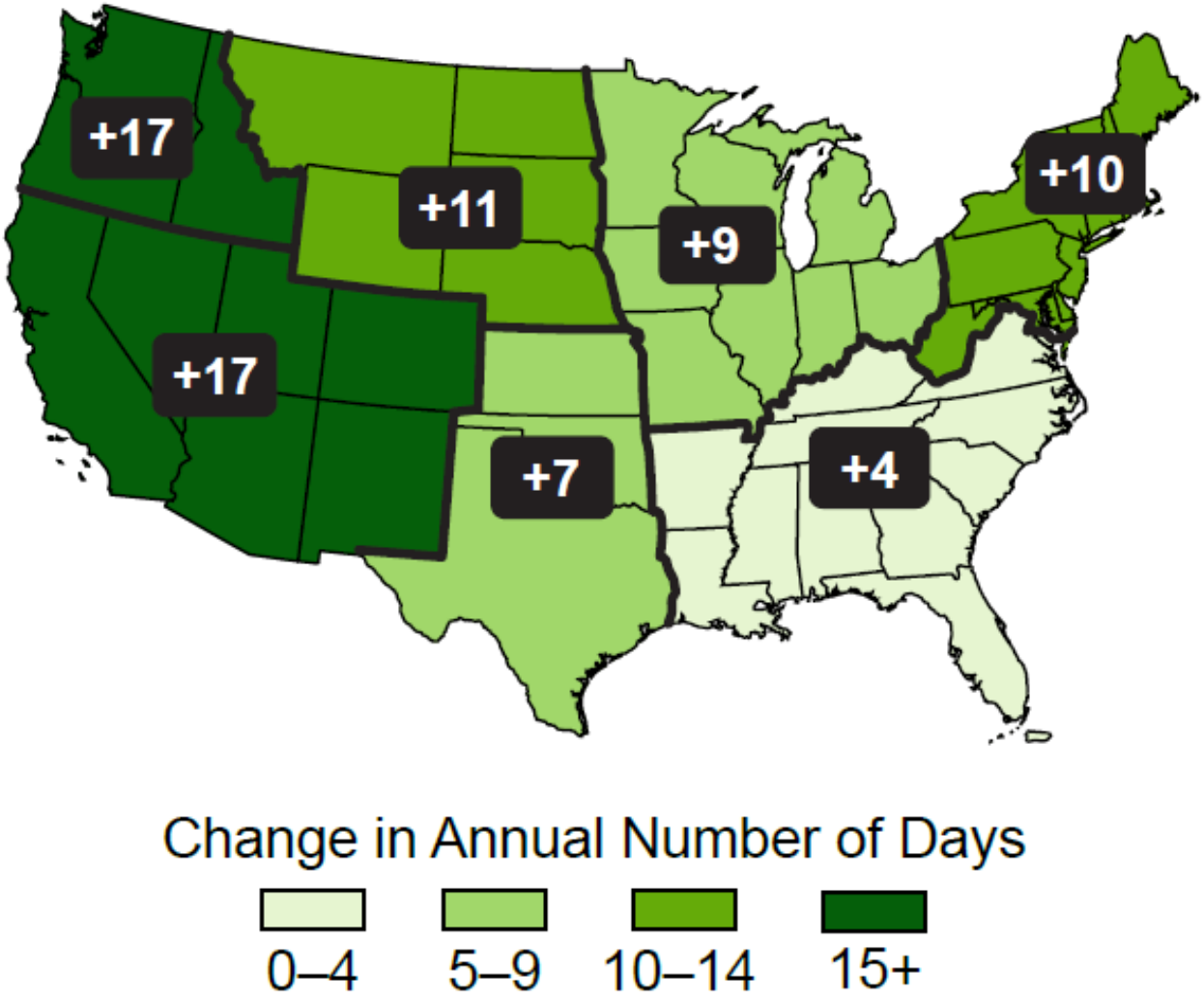
BIGGER…. **…and MORE FREQUENT.**



NCA 2018

Climate change or global warming?

Frost-free season, 1986-2016 compared to 1901-1960



NCA 2018

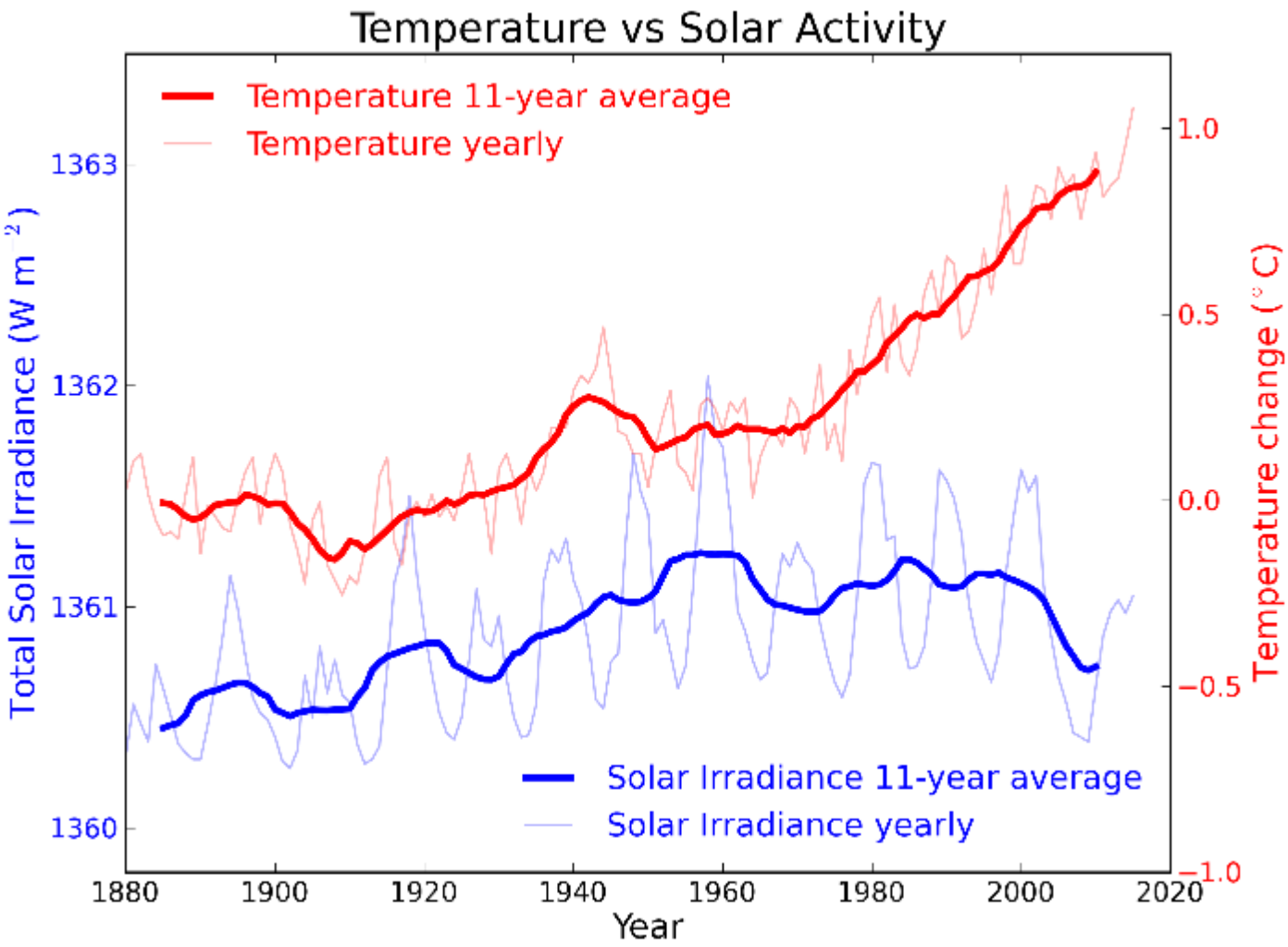
Is it climate change or global warming?

- 1.8F warming globally (115 yrs), same in US.
- 1.2F (30 yrs) in US, with regional variation.
- General increases in US annual precipitation, except in the southwest.
- More big rain events, more of annual precip within those events.

Both. The earth has warmed and the climate is changing as a result, with regional variations.

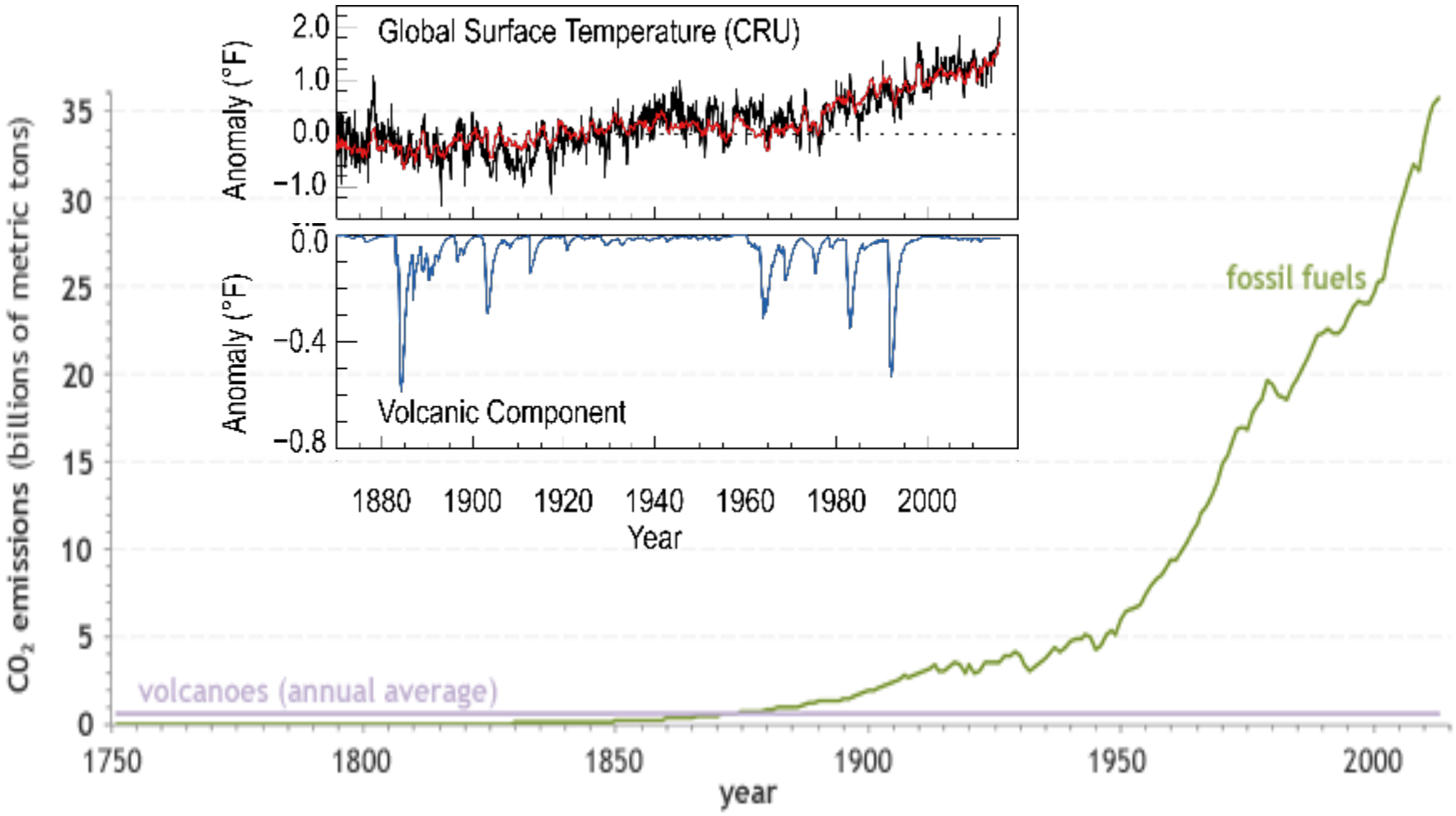
Isn't it the sun?
Or volcanoes?

Is it the sun?



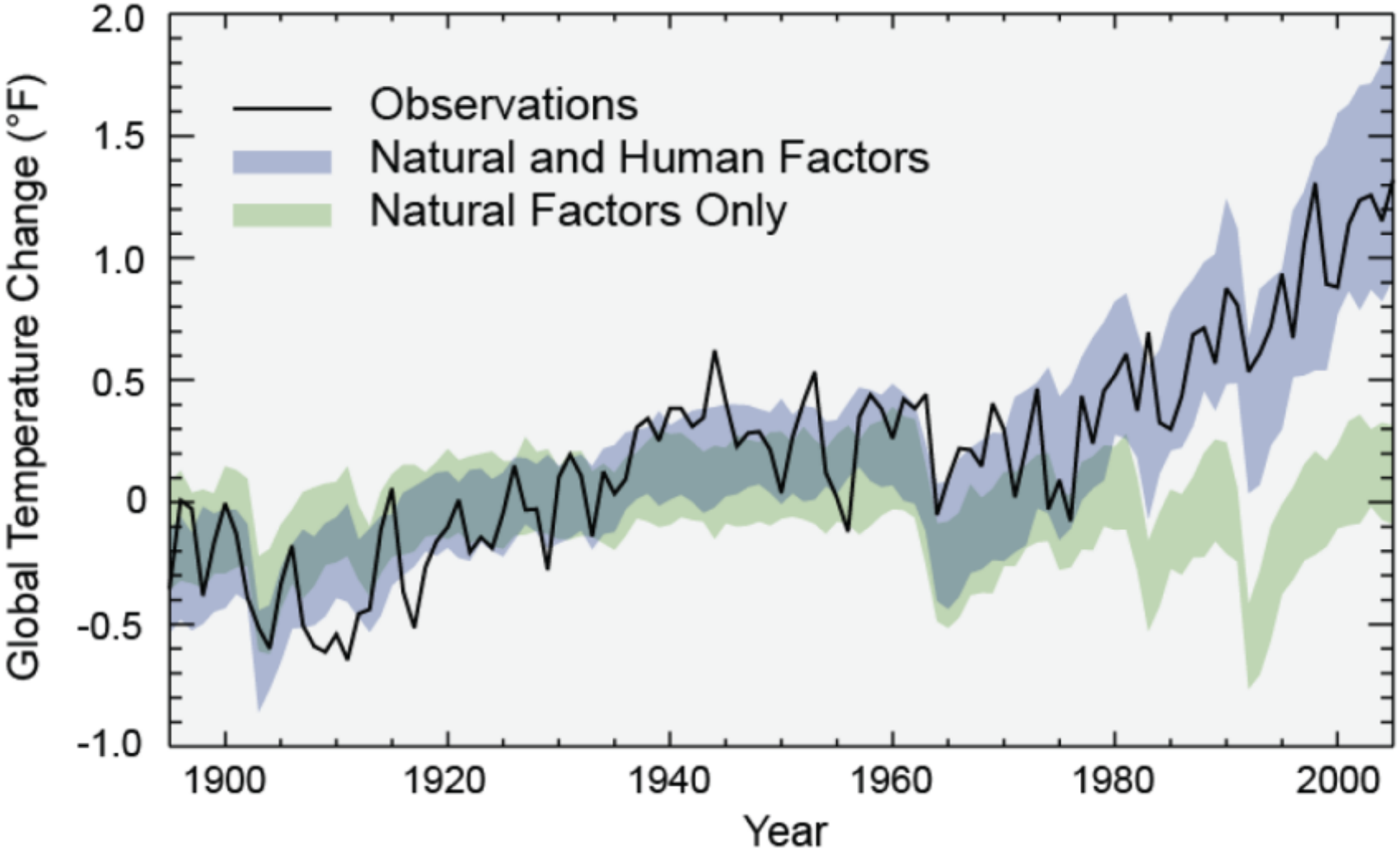
Courtesy of skepticalscience.com; see also – Bard and Frank 2006; Lockwood and Froelich 2007; Huber and Knutti 2011; Schurer et al. 2013

Is it the volcanoes?



NOAA Climate.gov; Burton et al. 2013; USGCRP NCA CCSR 2017

…the sun AND volcanoes?



NCA 2014; Huber and Knutti 2011

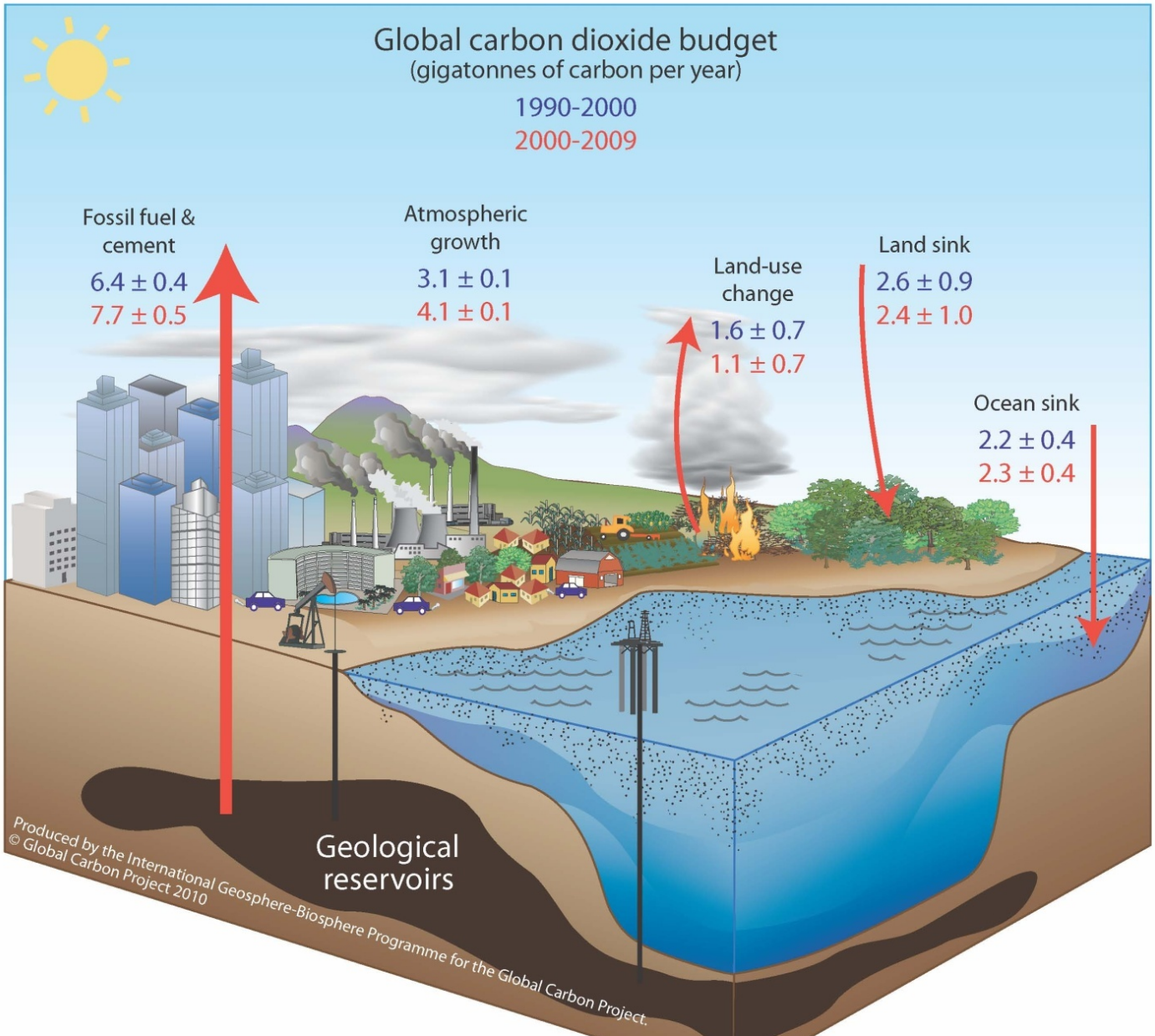
Could it be the sun, volcanoes, or anything natural?

- Nope.
- The sun has a minor or negligible warming effect
- The sun was more influential in the past
- Volcanoes emit GHGs, but also aerosols, and had a net cooling effect in recent decades
- Humans emit ~100x more GHGs than volcanoes

Greenhouse gases have dominated global warming since 1950 – major natural forcings have been negative.

The atmosphere is massive – how can we actually change it?

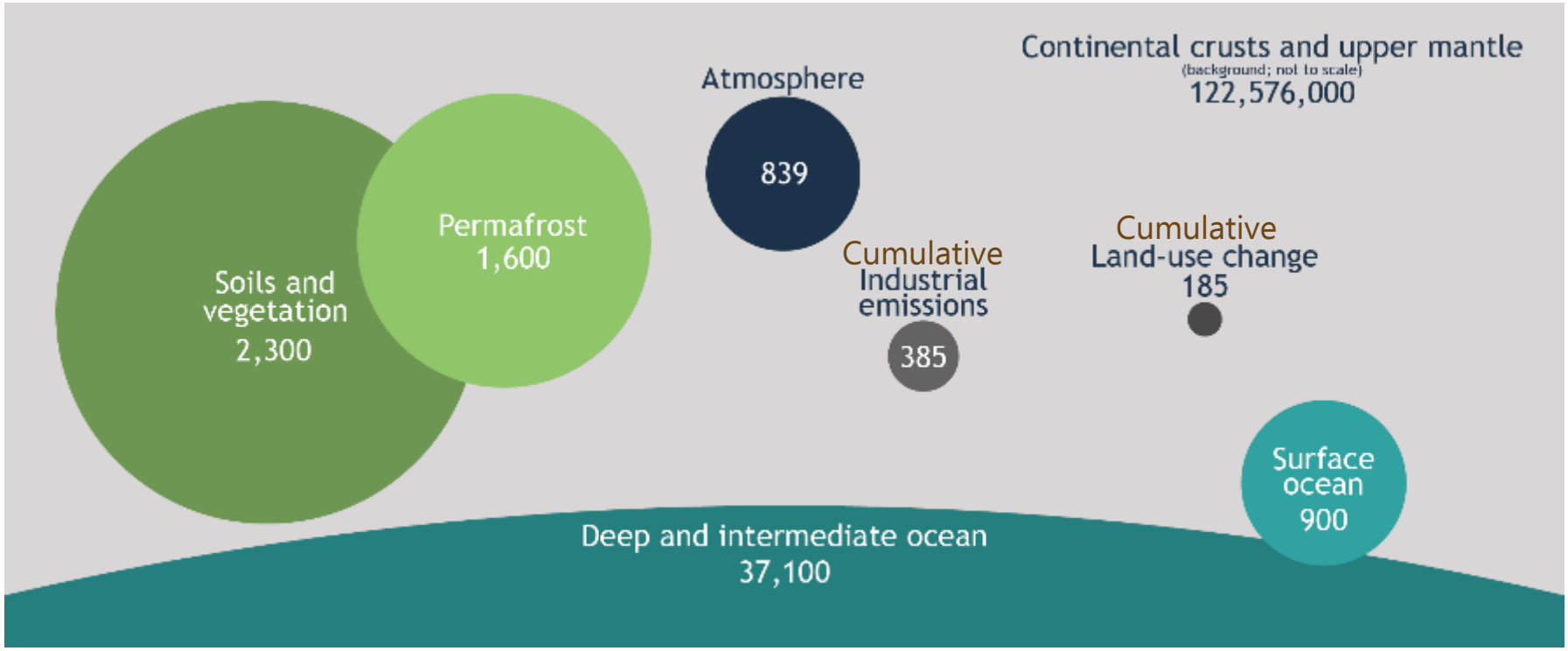
Anthropogenic change?



Net sources and sinks

Anthropogenic change?

Major global carbon reservoirs



Numbers in gigatons (Gt)

Janowiak et al. 2017

The atmosphere is massive, how can we change it?

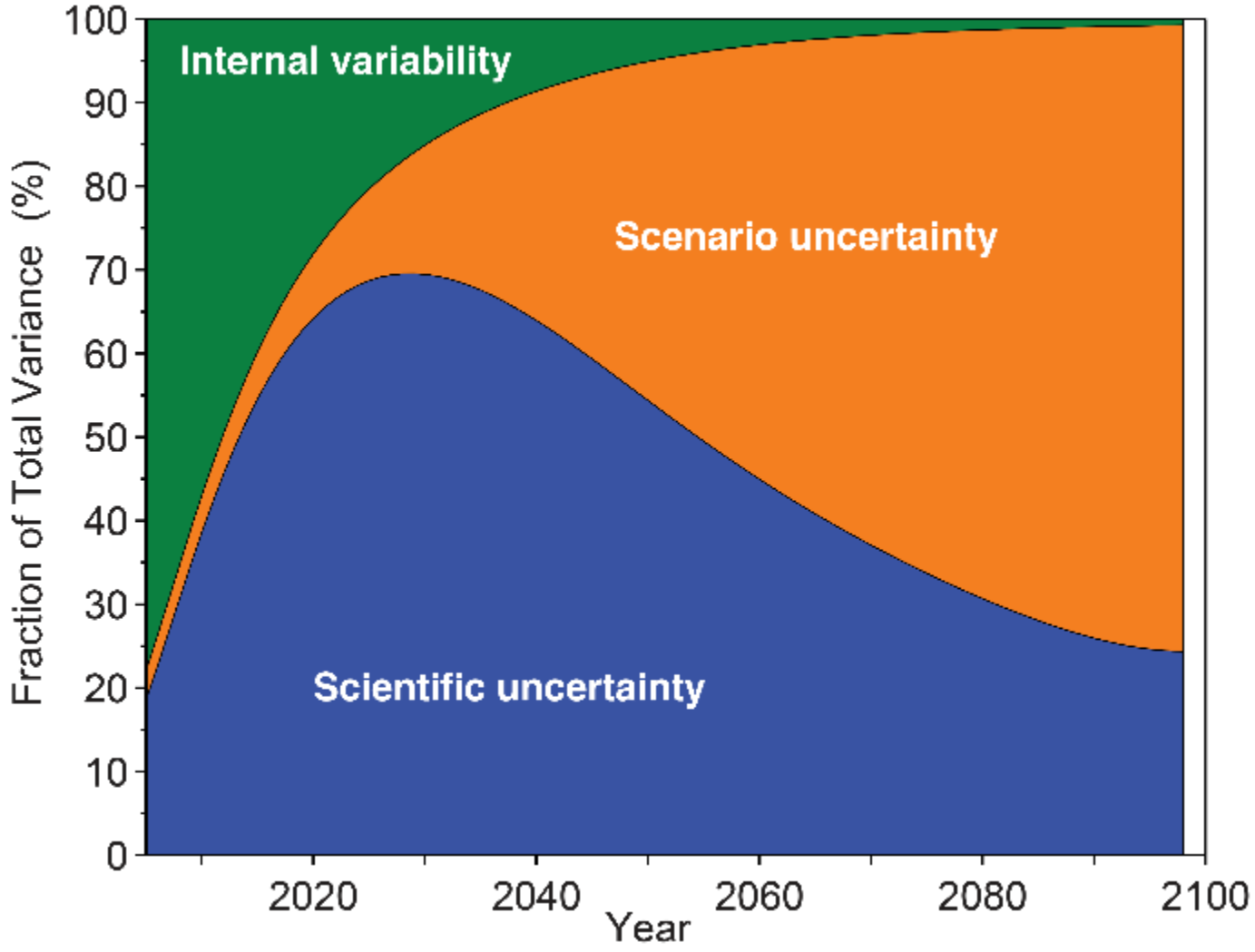
- We move massive amounts of carbon into the atmosphere.
- Fossil carbon is an addition – it has been isolated from the carbon cycle for millions of years.
- GHGs have different atmospheric lifetimes – CO_2 may last decades to centuries.
- Land cover change transfers carbon to the atmosphere.

The measurement record clearly shows our additions to the atmosphere.

Isn't future climate change uncertain?

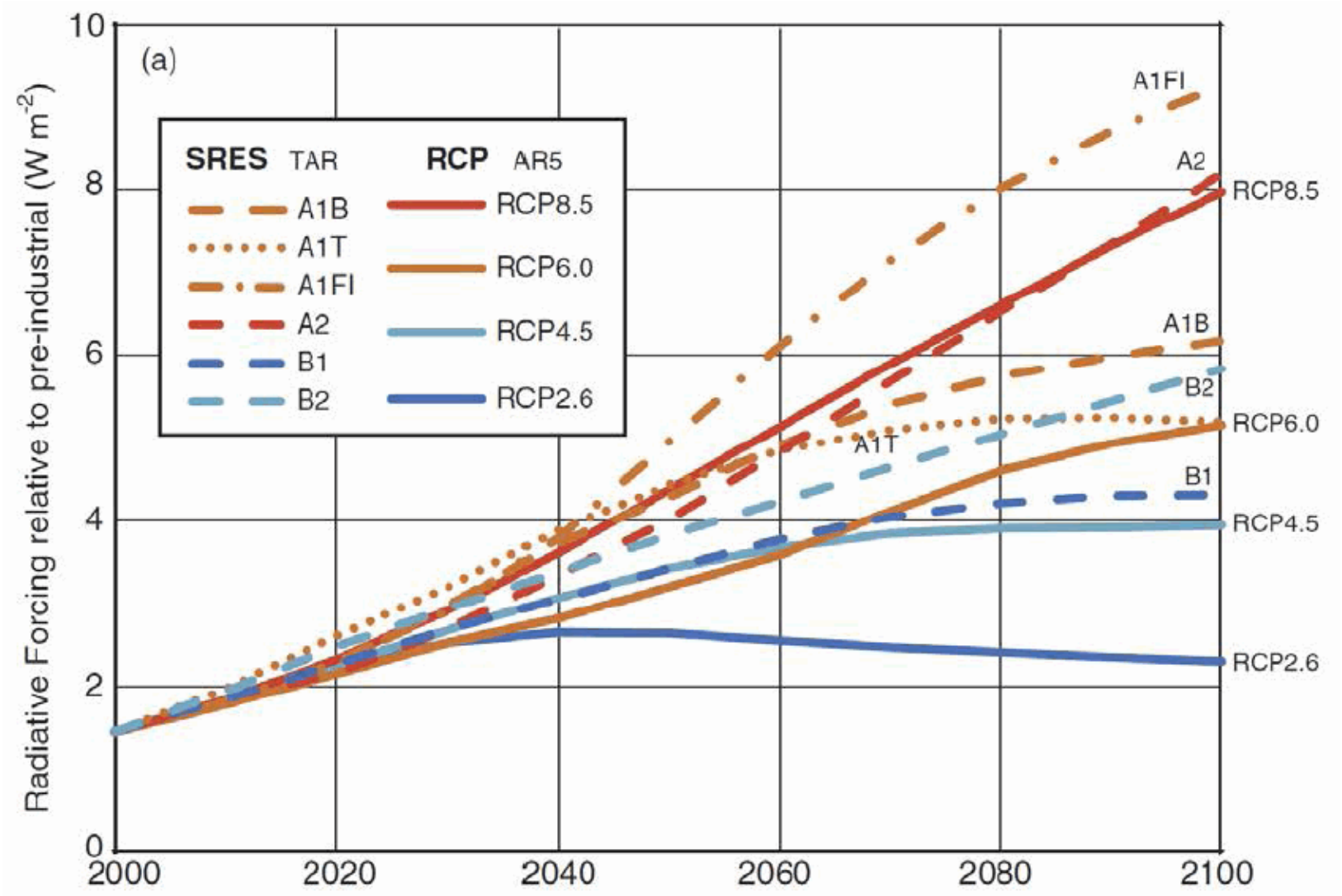
Also: I don't trust climate models!

Uncertainty …pieces



USGCRP NCA CCSR 2017

Uncertainty …scenarios

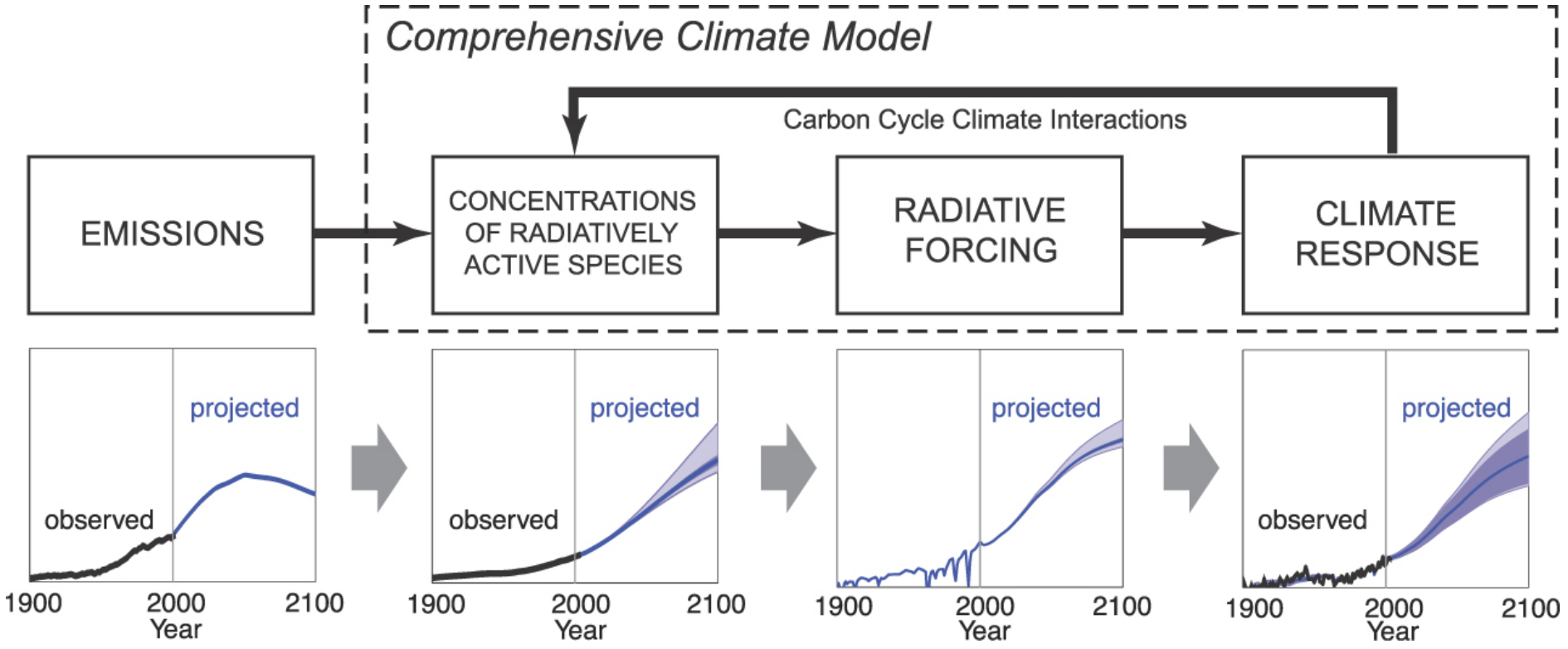


IPCC 2014, AR5

Uncertainty ...feedbacks

Scenario uncertainty

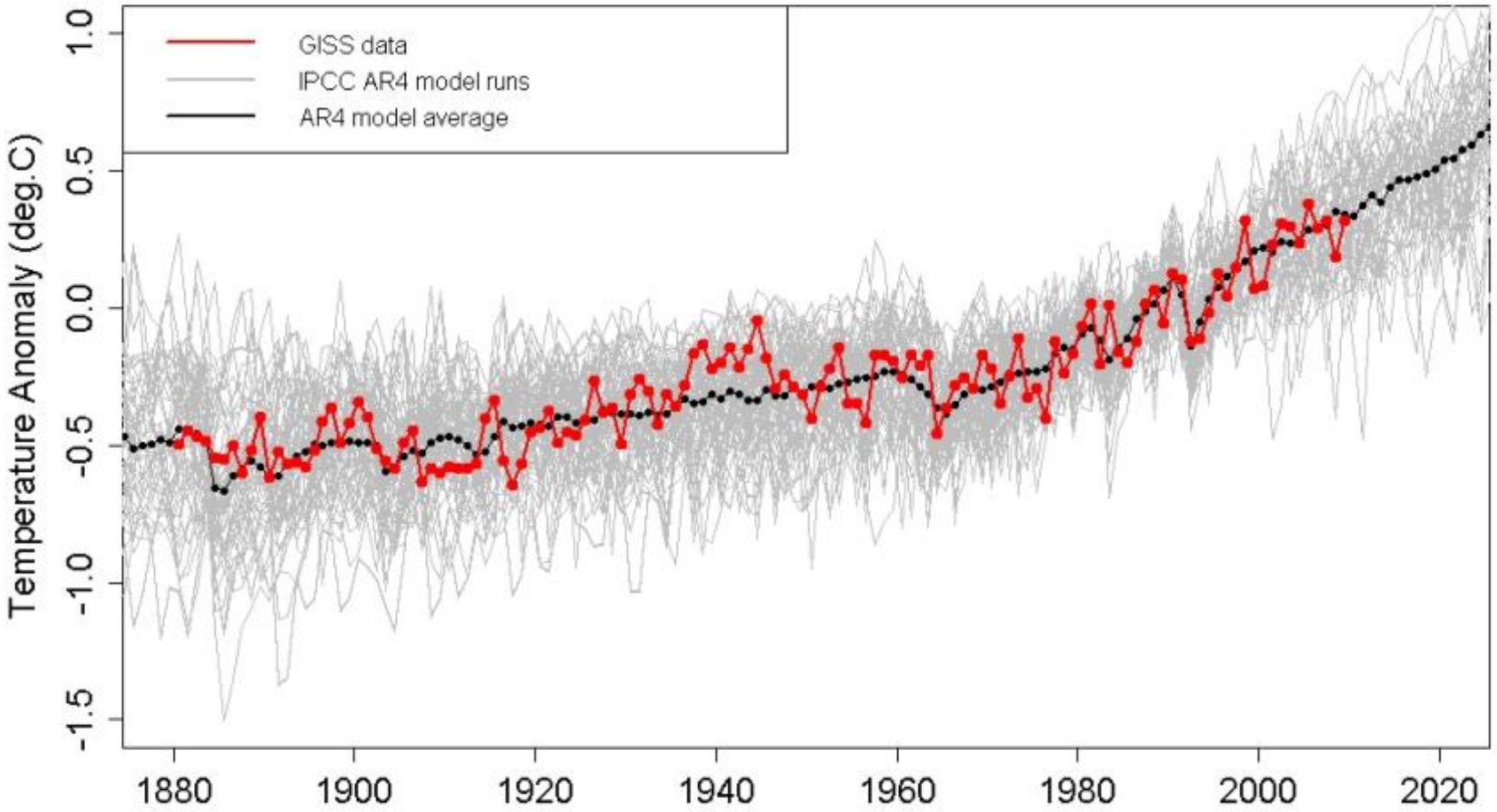
Scientific uncertainty
(model sensitivity)



IPCC 2007

Uncertainty?

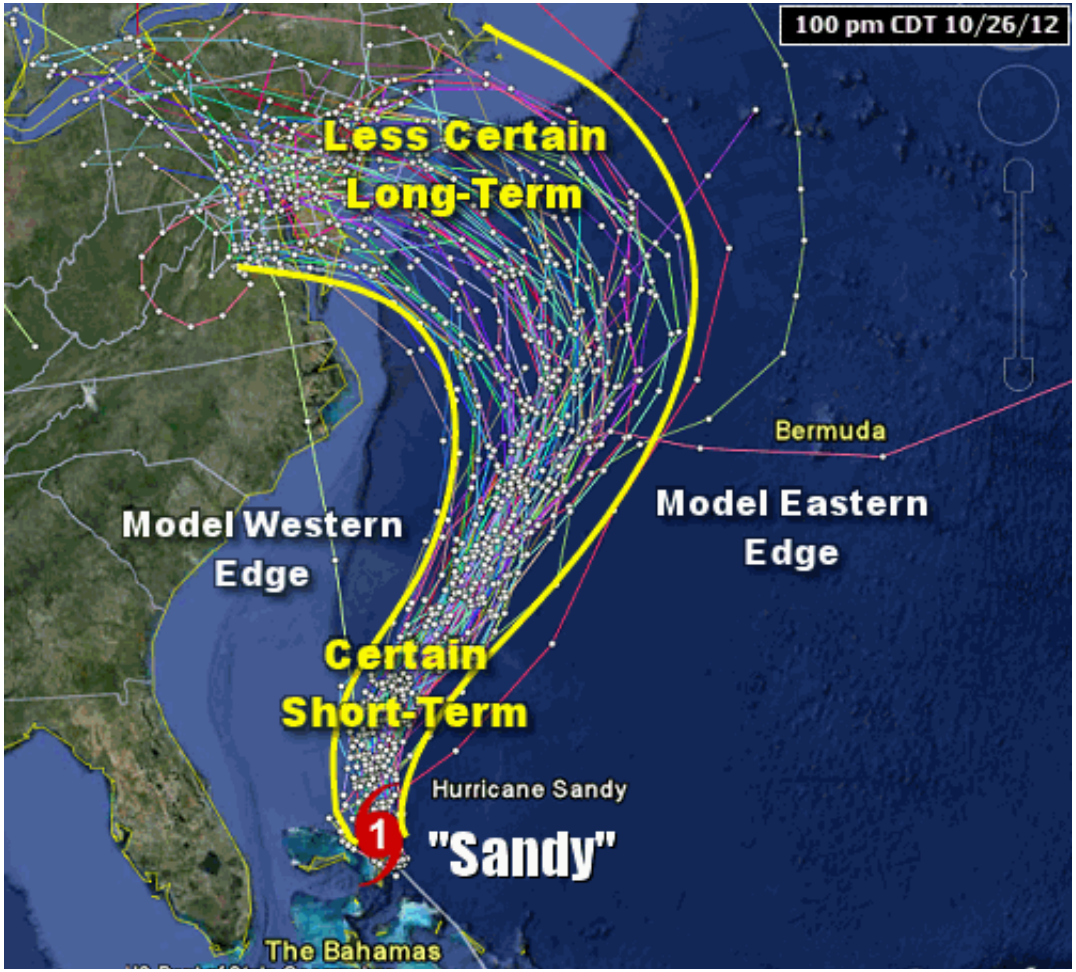
From IPCC AR4: 22 models, 106 runs



*Omits Canadian CCCMA

Tamino, 2010 (blog: http://tamino.wordpress.com/)

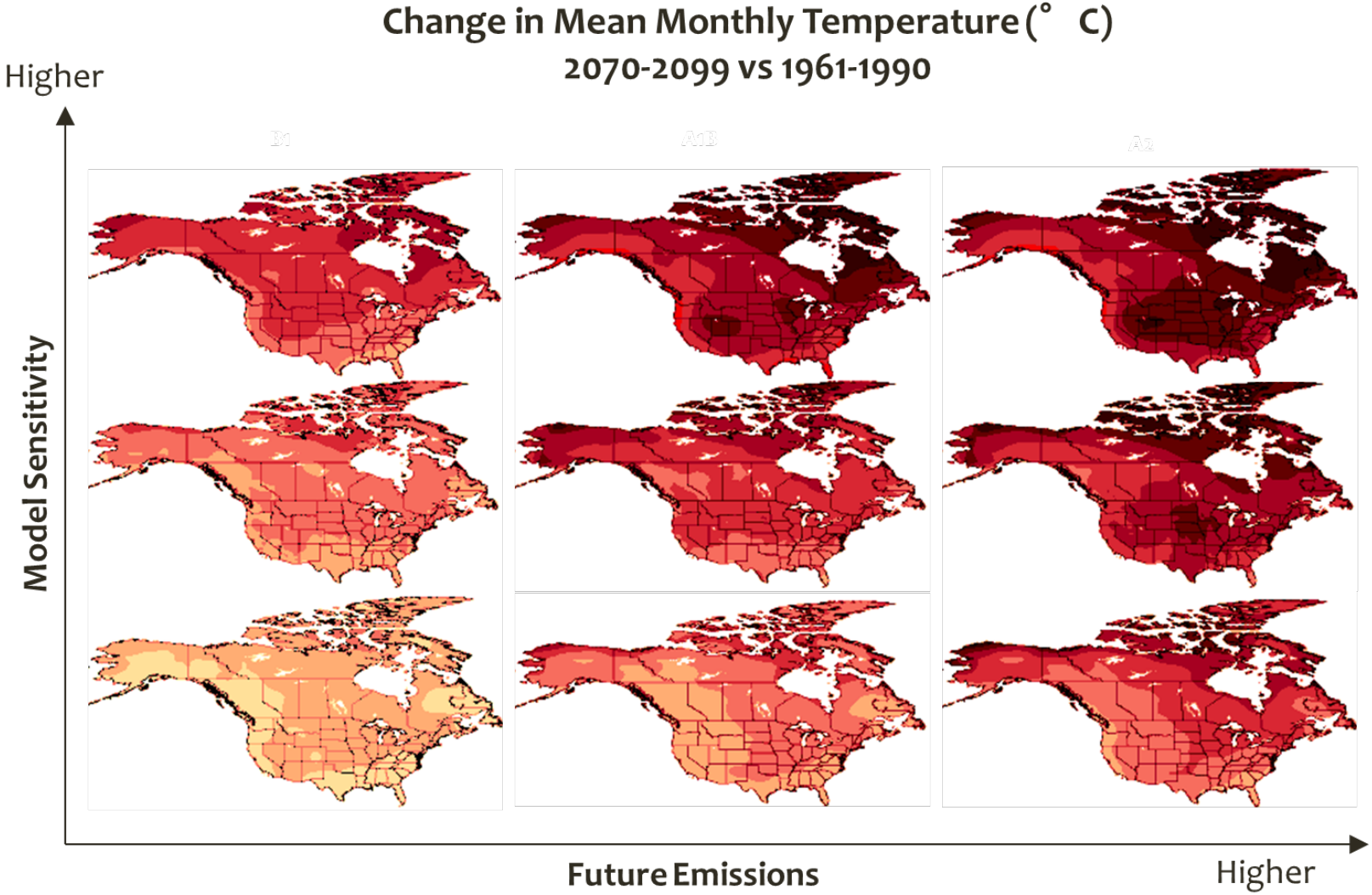
Uncertainty?



Certainty is a myth.

Uncertainty?

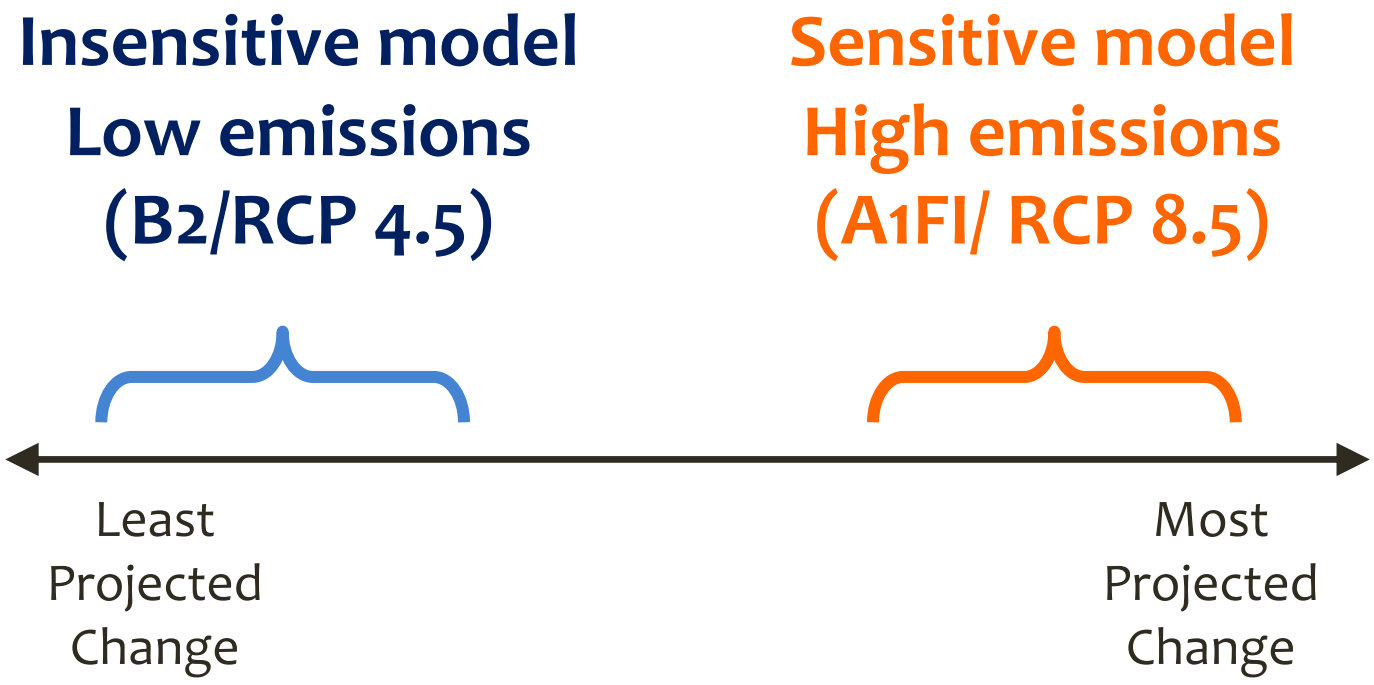
“Plausible climate futures”



Uncertainty?

Certainty is a myth.
Embrace uncertainty and manage risk.

Simple representation of uncertainty:



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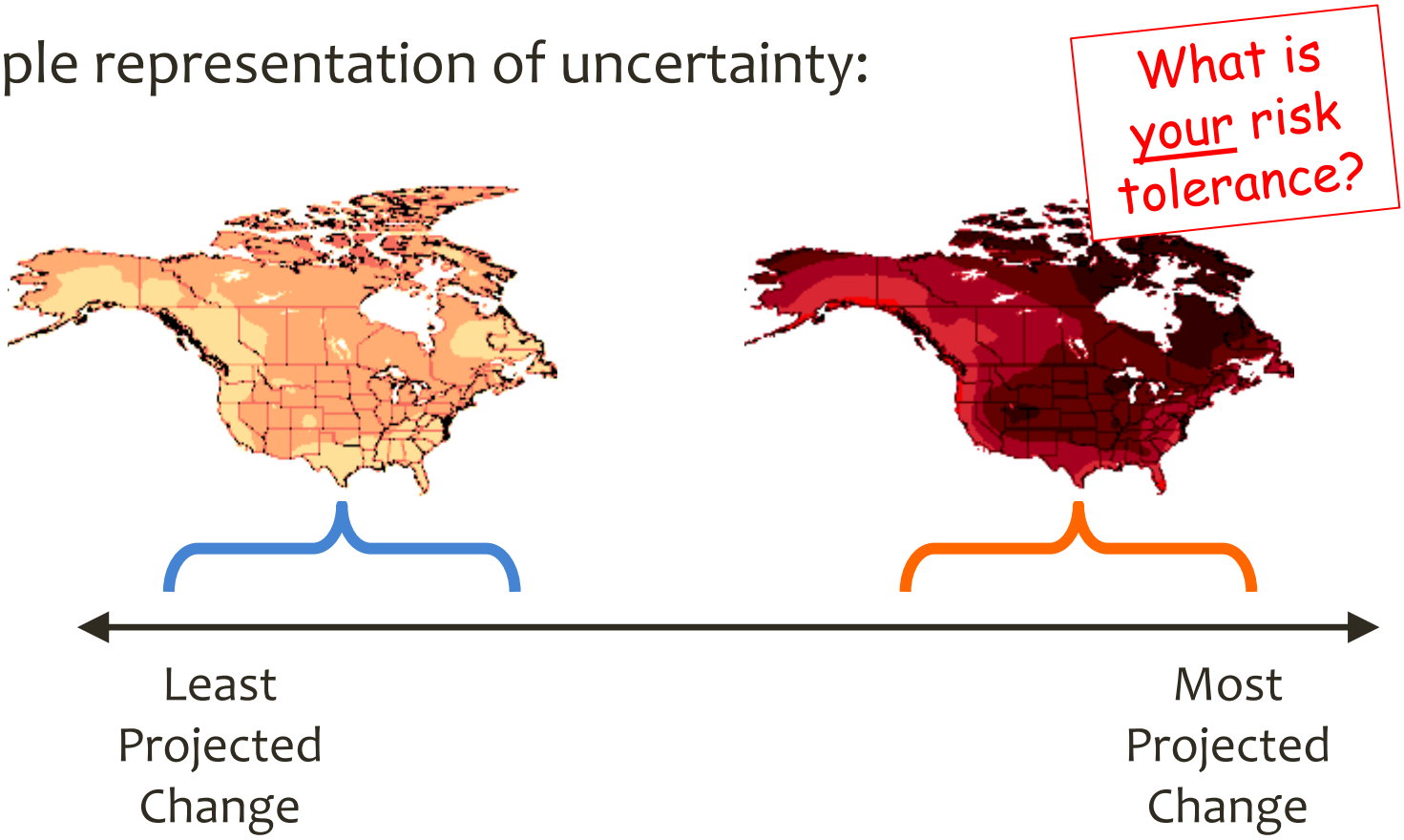

Isn't future climate change uncertain?

- Change is certain. Warming is certain.
- Distribution is uncertain. Variability has increased.
- Models do well globally with air temps, not with precip, and will likely never be "good enough" at a management scale.
- Great at multi-decadal trends, poor at multi-year.
- Emissions uncertainties are inherent.

Models are tools, not reality – use multiple models, think long term, and consider a range of futures.

Bonus Question!!

Is the world going to end in 12 years?

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*Short answer: not from climate change**

** But things will get harder*

IPCC SR15 (Special Report on 1.5 C)

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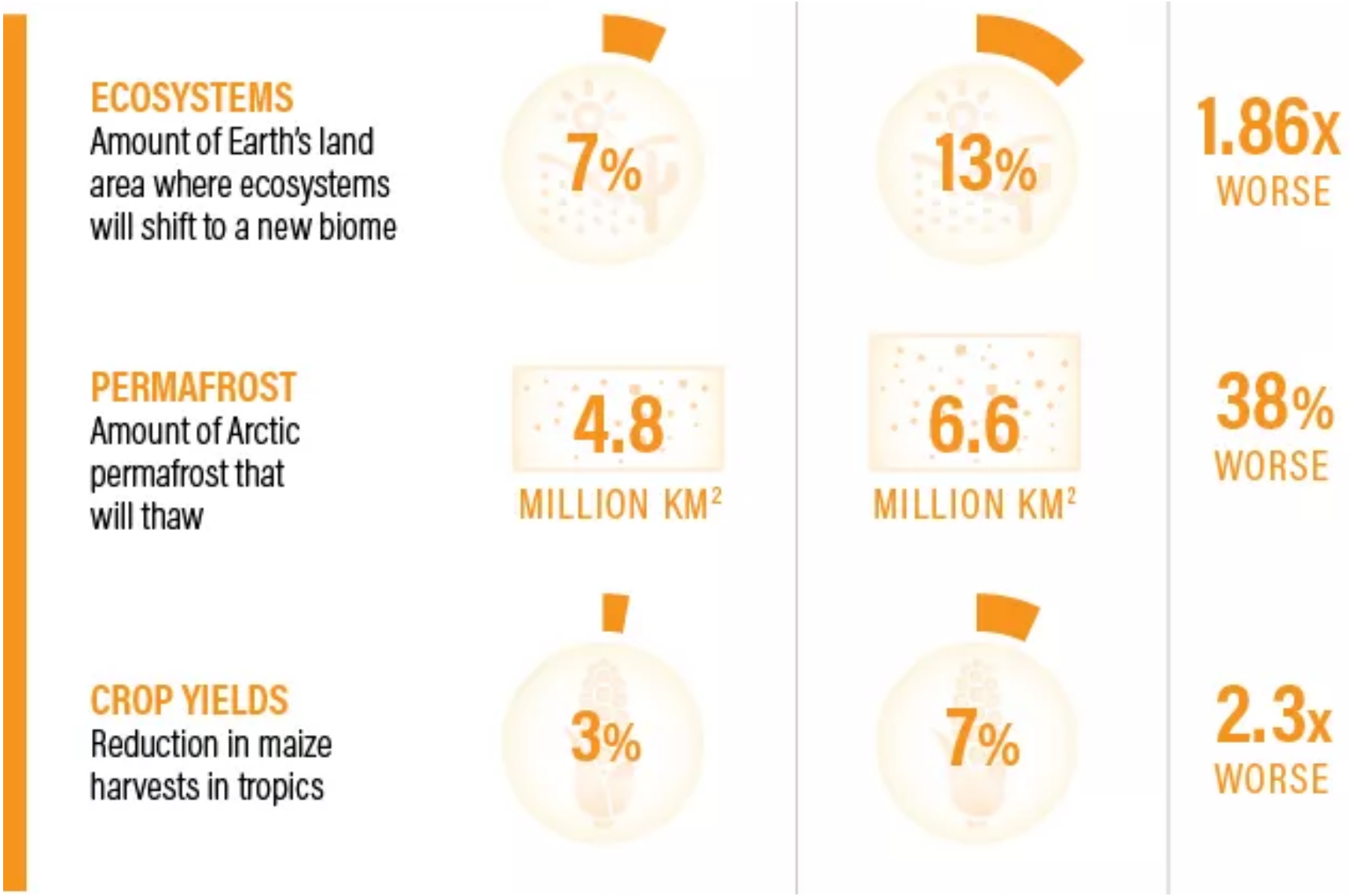

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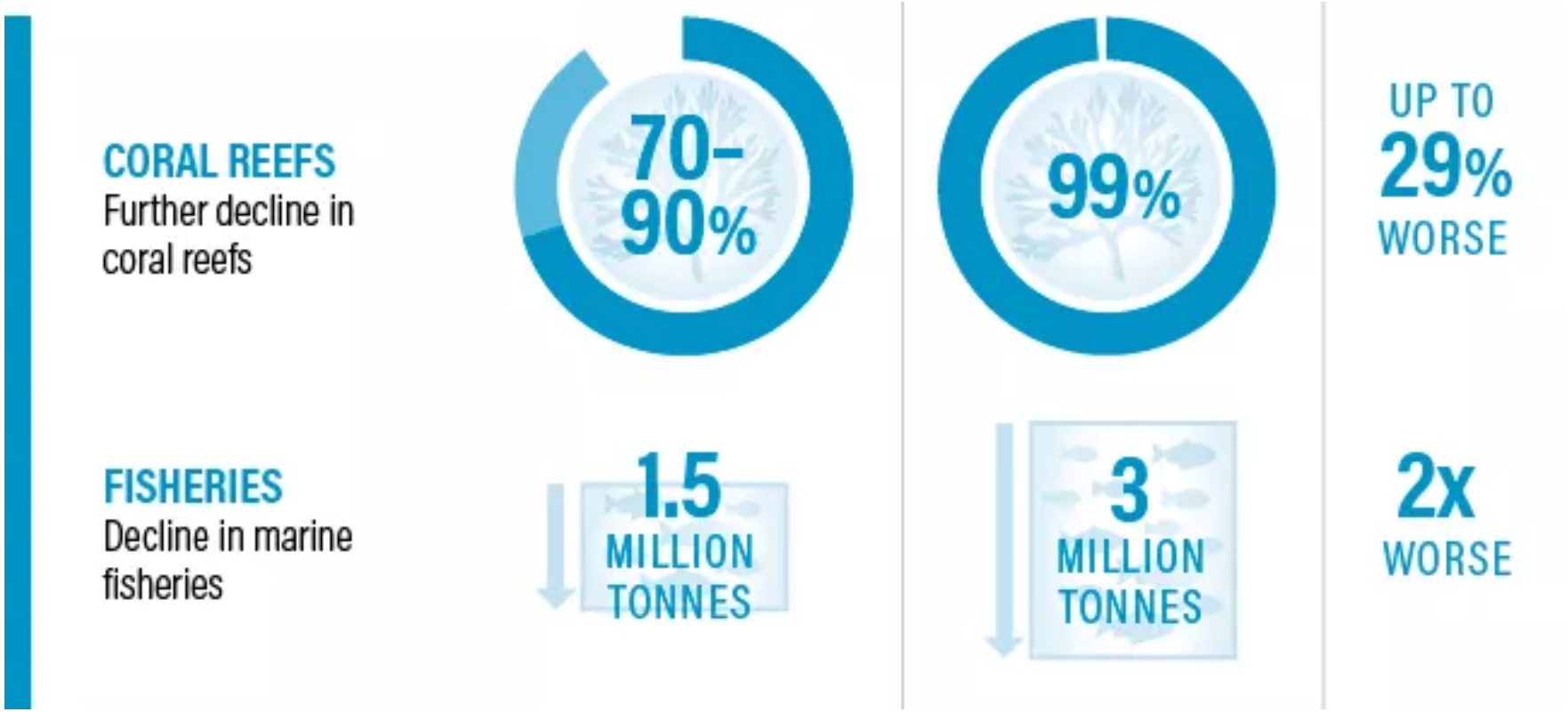

IPCC SR15 (Special Report on 1.5 C)

- Likely to hit 1.5C above pre-Industrial in 12-32 yrs
- More likely we'll hit 2.0C
- 2.0C is much worse than 1.5C
- Much more expensive and difficult to get back to 1.5C

World isn't ending, but will become much more damaging and expensive

Concluding thoughts

The climate is changing

- overwhelming evidence and scientific consensus

Not "if, but "how much"

Climate certainty is a foregone luxury

- planning for a "specific" or "average" future is risky

Manage risk

This won't get better during our careers

- sorry

Embrace uncertainty

Thank you!