
Climate
Up Close.

# Our team

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# Support

## Jake Seeley

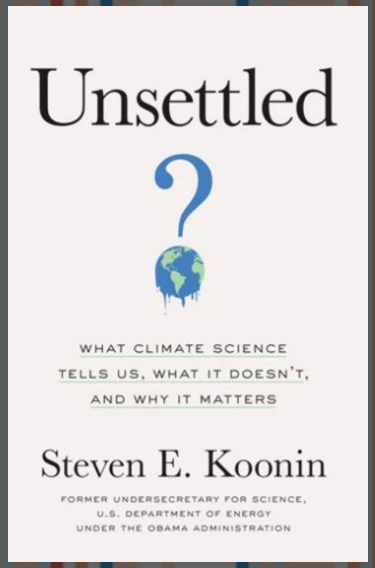
Alumnus & tour host

## Emma Ignaszewski

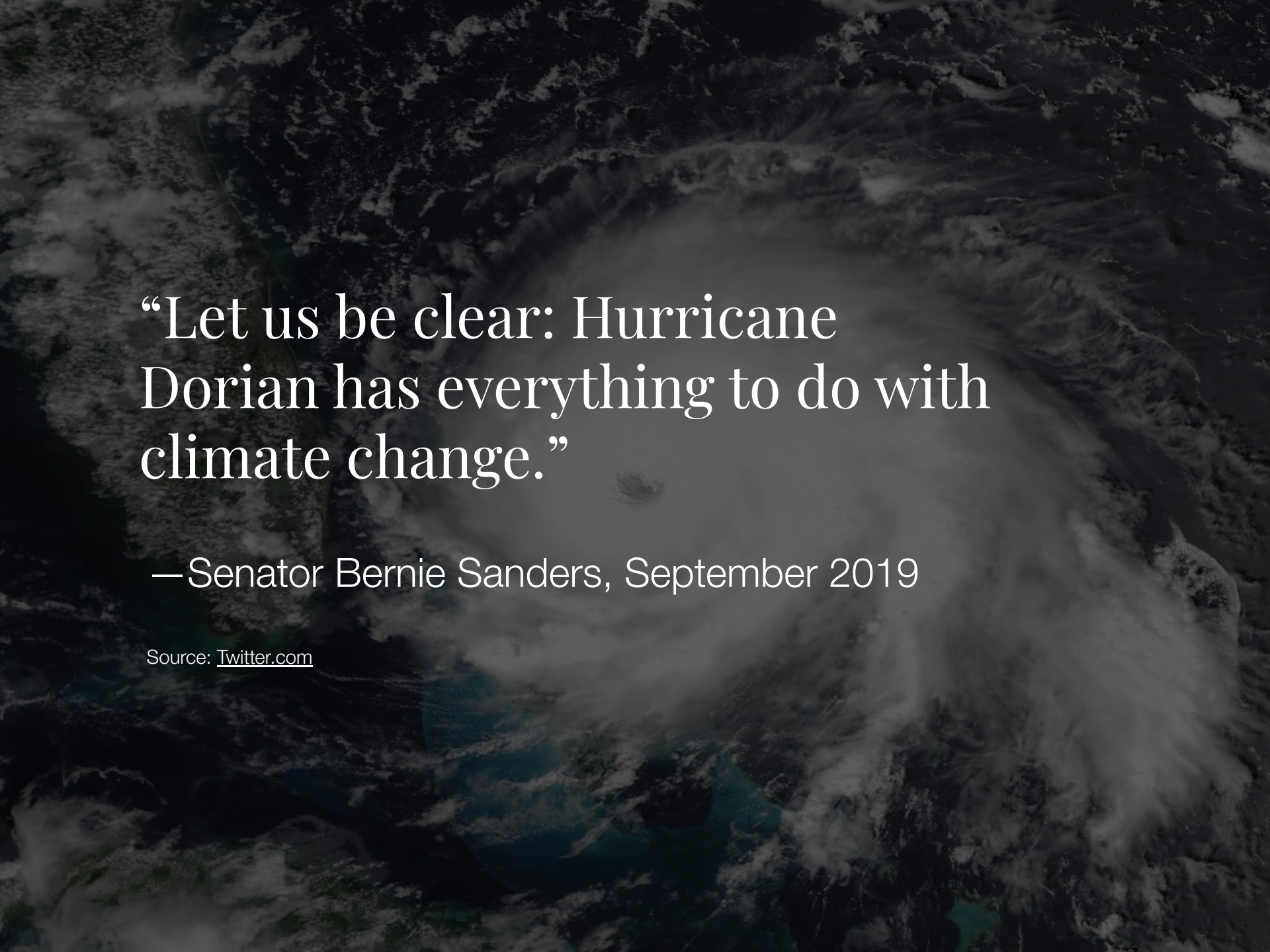
Communications strategy


Our tours
Chicago tour 2023
Central PA tour 2019
NH tour 2024
New Jersey tour 2022
Philly area tour 2020
Florida tour 2022
WISCONSIN
MICHIGAN
Toronto
MAINE
VT
NEW YORK
IOWA
ILLINOIS
OHIO
INDIANA
WEST VIRGINIA
KENTUCKY
VIRGINIA
OKLAHOMA
TENNESSEE
NORTH CAROLINA
ARKANSAS
Atlanta
MISSISSIPPI
SOUTH CAROLINA
Dallas
ALABAMA
GEORGIA
LOUISIANA
Houston
FLORIDA
Miami
Gulf of Mexico
Boston

“Heat waves in the U.S. are now no more common than they were in 1900.”




—From *Unsettled* by Steven Koonin, Physicist and former Undersecretary for Science at U.S. Department of Energy


“Let us be clear: Hurricane Dorian has everything to do with climate change.”
—Senator Bernie Sanders, September 2019
Source: Twitter.com

“The world is reaching the tipping point beyond which climate change may become irreversible.”

—Kofi Annan, Former Secretary-General of the United Nations

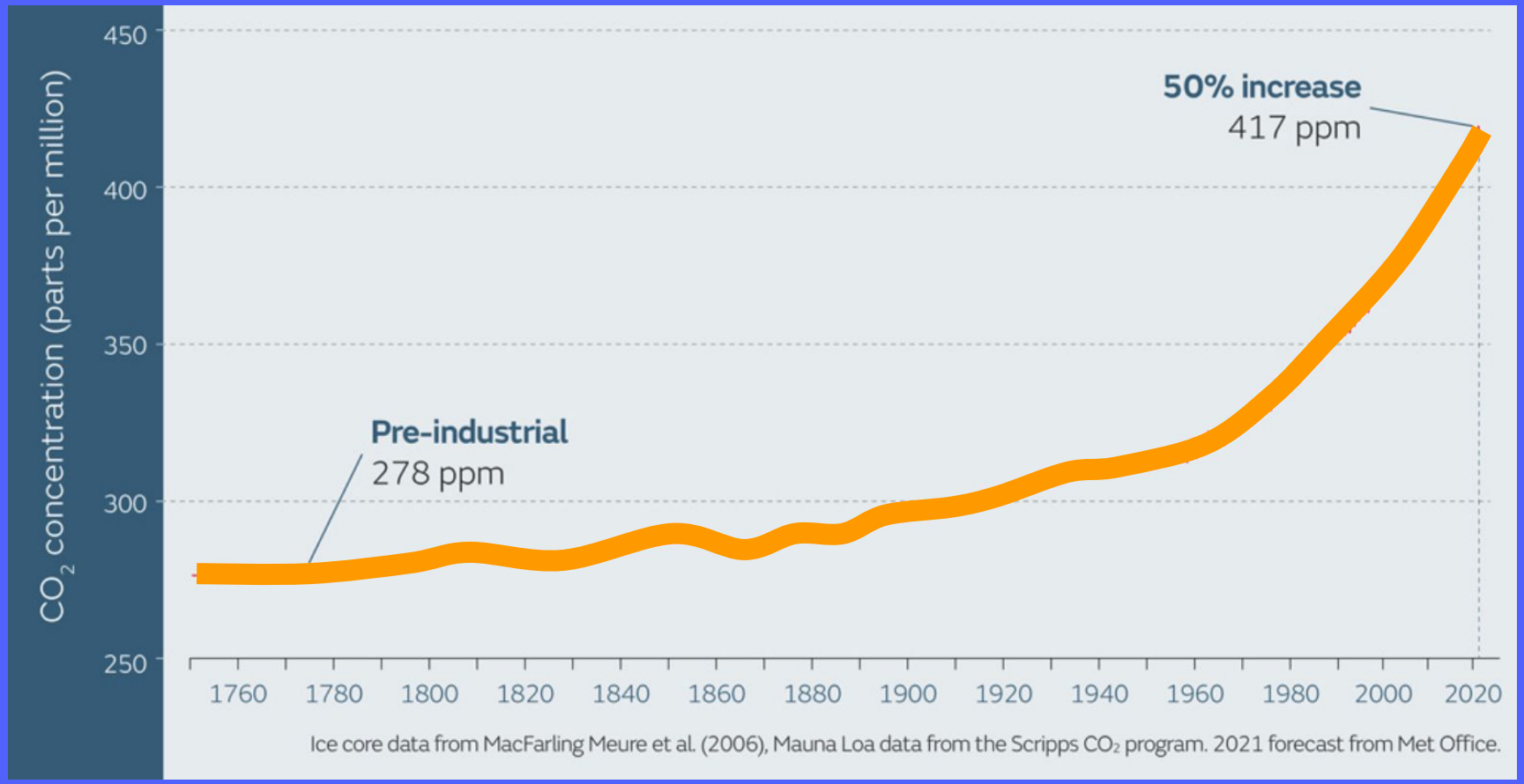
Source: The Guardian

# The Landscape of Climate Knowledge

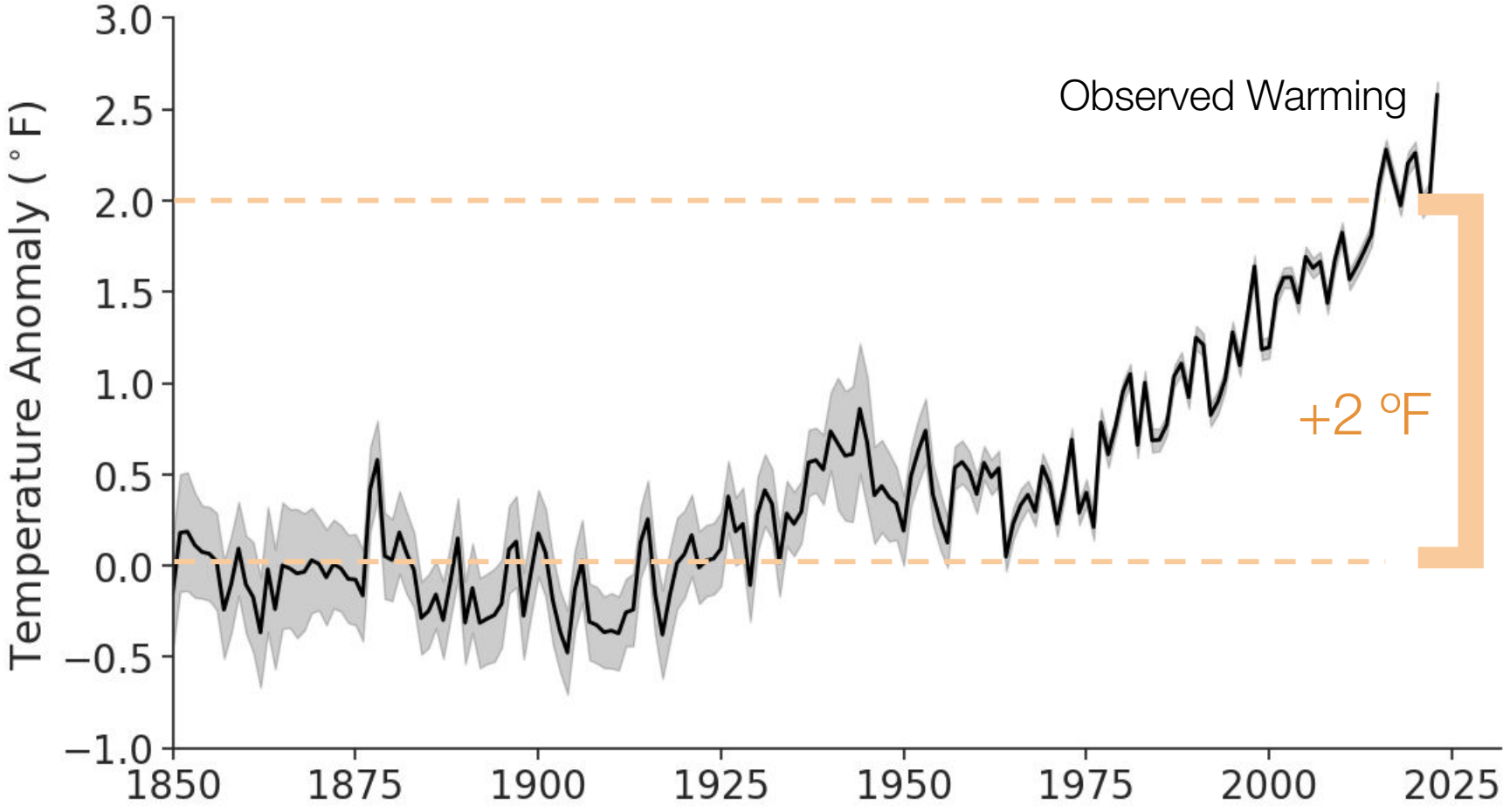
## What's *settled*?

## What's *uncertain*?

# Atmospheric $CO_2$ concentration is rising.

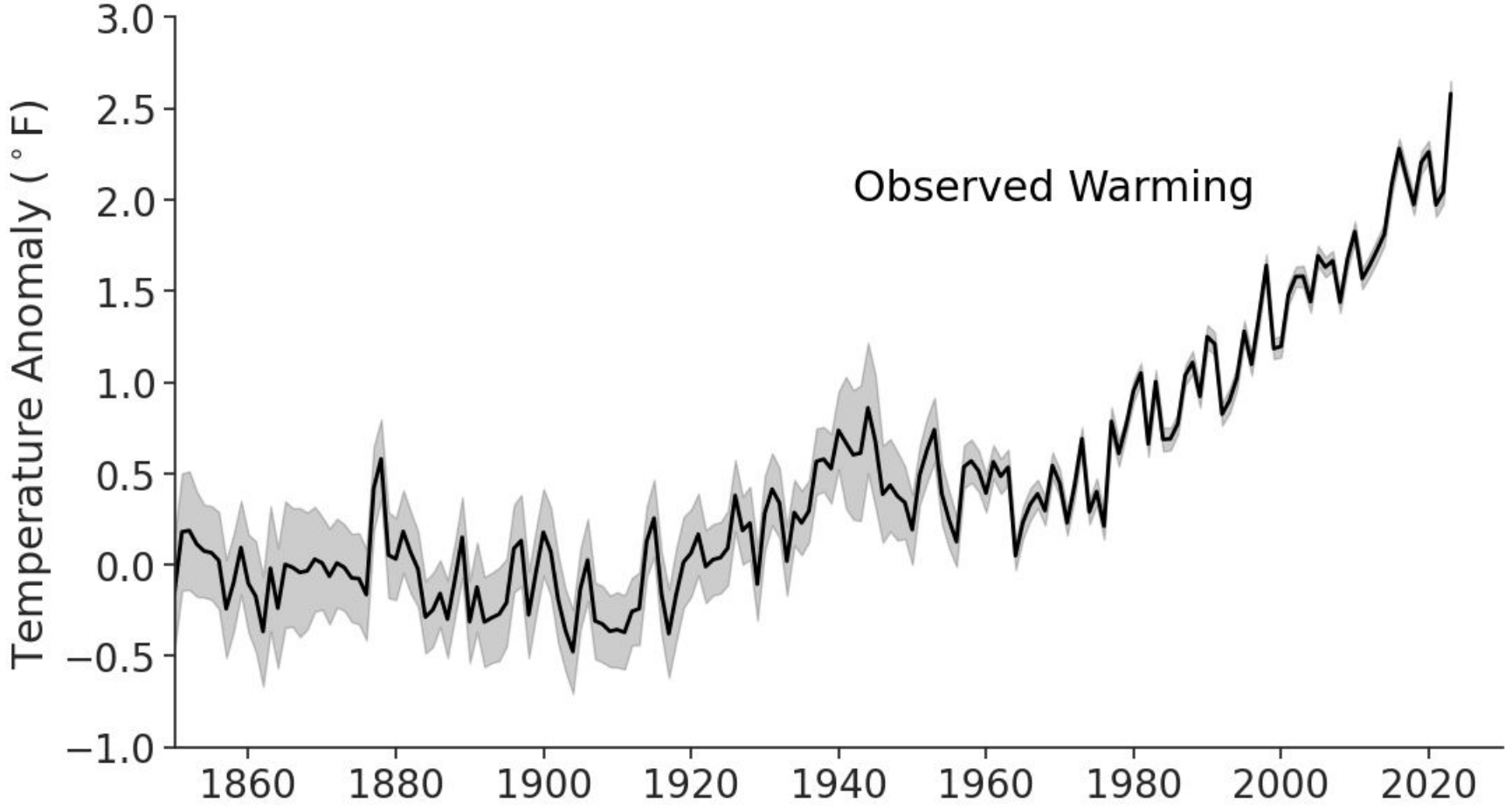


# Global temperatures are rising.



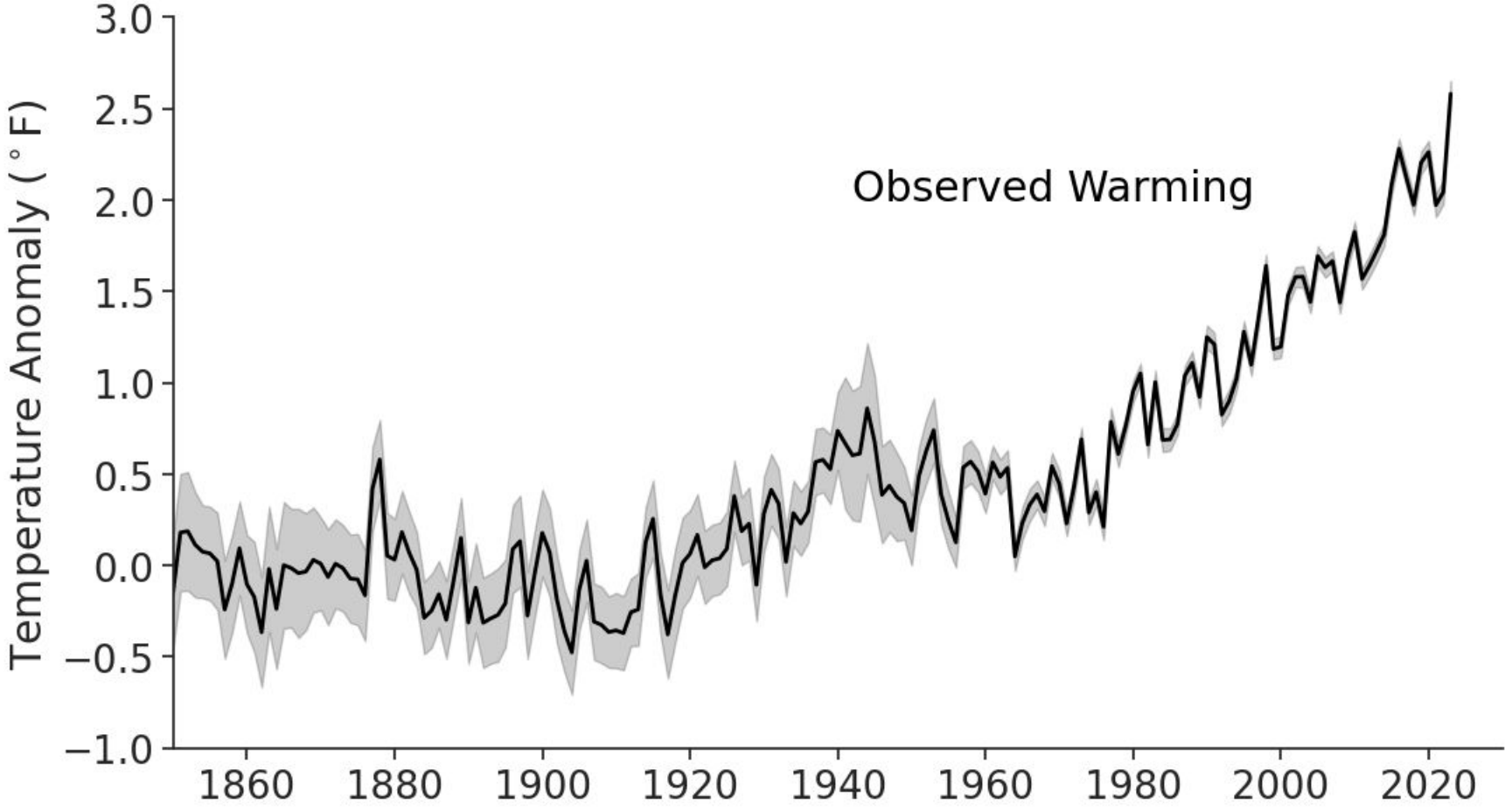

Source: HADCRUT5 (Met Office).

# Natural changes alone fail to account for the observed warming.



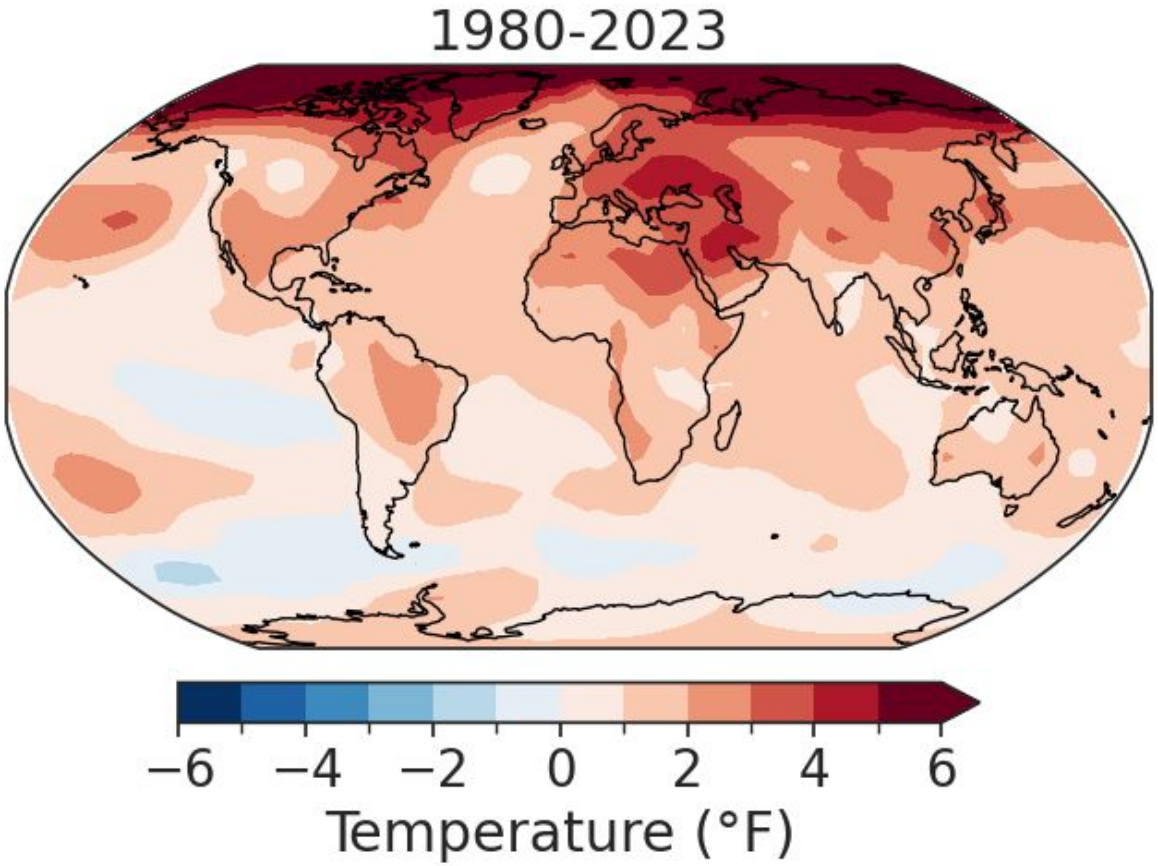

Source: Modeled natural changes from FAQ 3.1, Figure 1 in IPCC, 2021: Chapter 3. The Physical Science Basis. Observed warming is HADCRUT5.

# Adding in human changes, we get a closer match.




Source: Modeled natural changes from FAQ 3.1, Figure 1 in IPCC, 2021: Chapter 3. The Physical Science Basis. Observed warming is HADCRUT5.

# What about the *pattern* of warming?



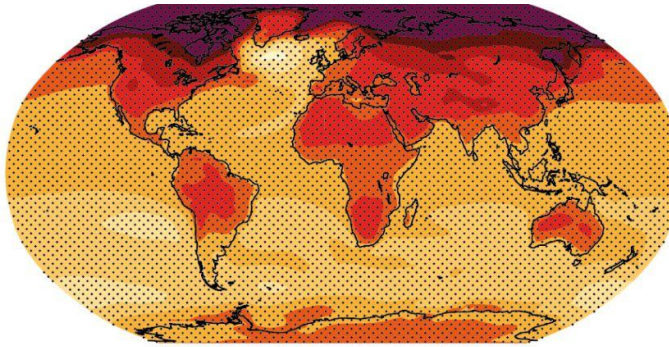

Key points:

Warming is enhanced over land.

Warming is enhanced in the Arctic.

There are weaker changes over the Southern Ocean.

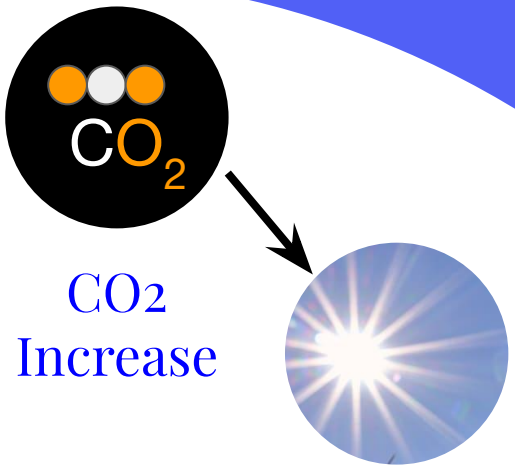
Climate models



Top: HADCRUT5 (Met Office). Changes based on linear regression.
Right: IPCC (2013), *Climate Change 2013: The physical science basis*. Figure SPM 8

# The Landscape of Climate Knowledge

## *Uncertain*




$CO_2$ Increase

***Settled***

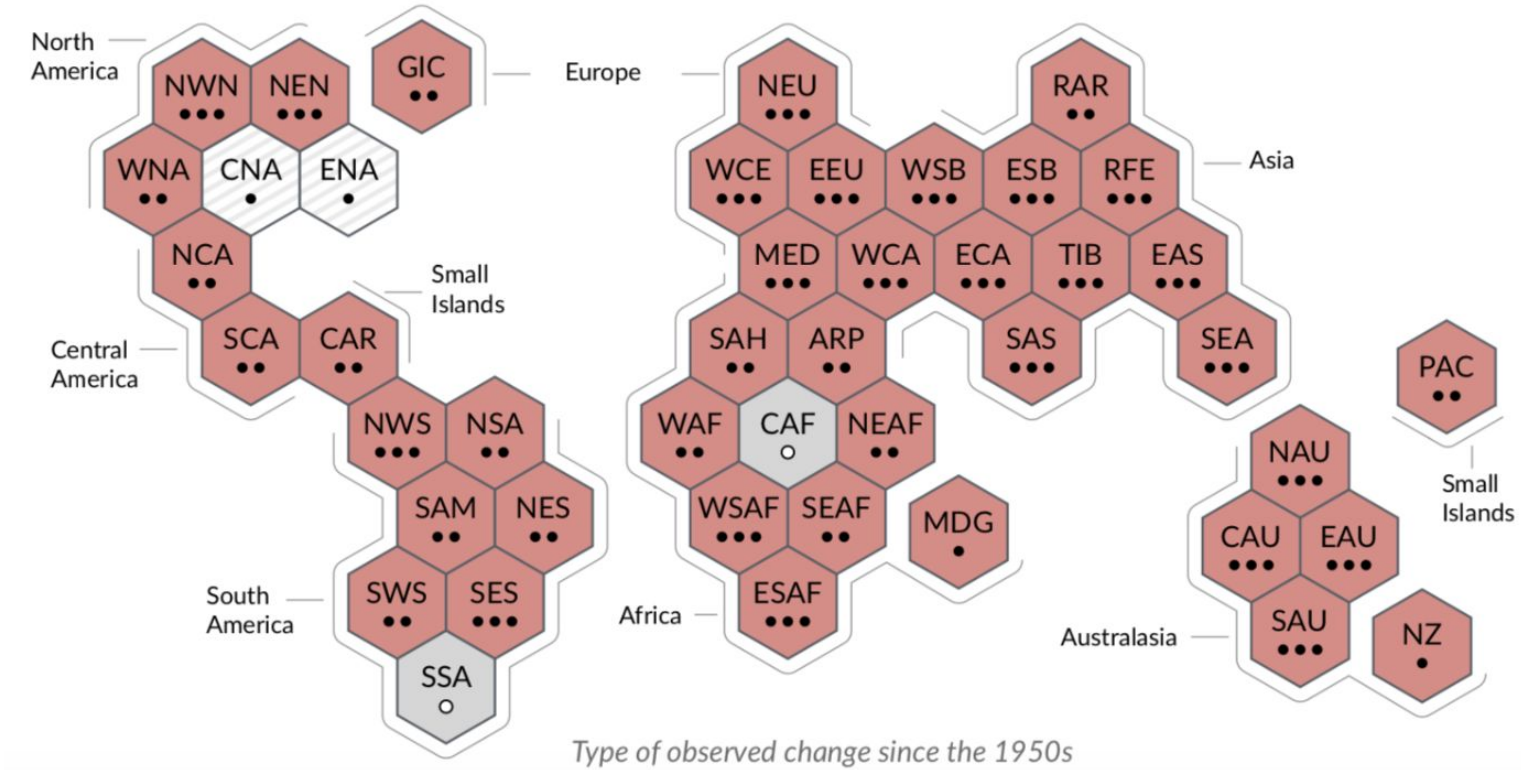
Average Temperature Increase

Which impacts of warming are *settled*?

# Heat waves have become 3°F hotter.

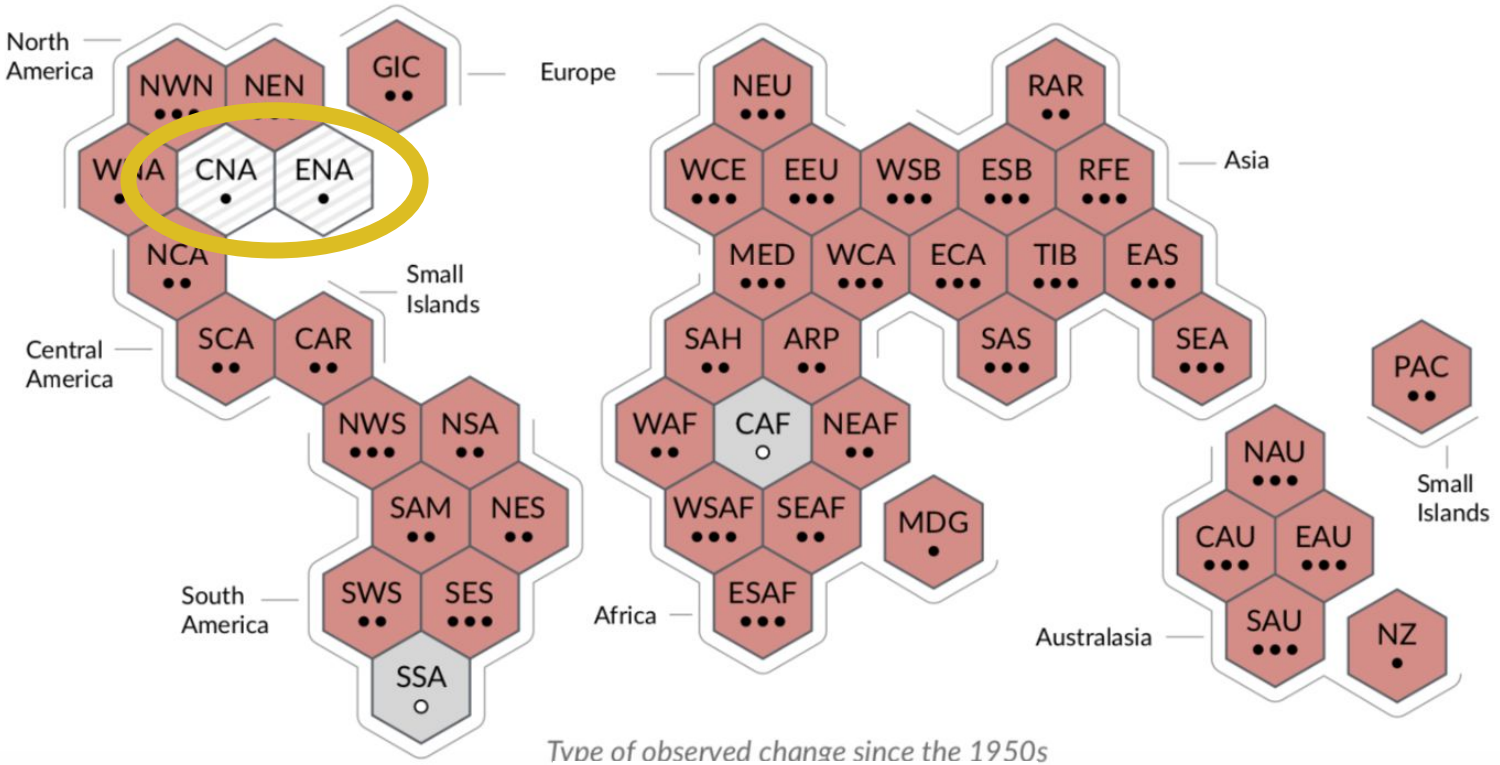
Source: IPCC AR6 Summary for Policymakers, Fig. SPM.6, based on 1.3ºC of global mean warming + ~20% land amplification factor

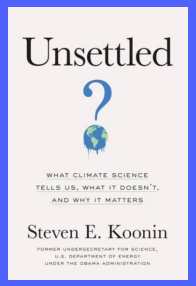
# Heat waves are intensifying *globally*.




Source: IPCC (2021), *Climate Change 2021: The physical science basis*. Figure SPM 3

# Heat waves are intensifying *globally*.




"Heat waves in the U.S. are now no more common than they were in 1900."
—Steven E. Koonin, *Unsettled*

True regionally, but the *exception* rather than the rule.

Source: IPCC (2021), *Climate Change 2021: The physical science basis*. Figure SPM 3

# Average sea level rise since 1900

**8 inches**

of sea level
rise to date

Exacerbates coastal flooding
Hurricane Sandy, 2012

Source: IPCC AR6 Table 9.5

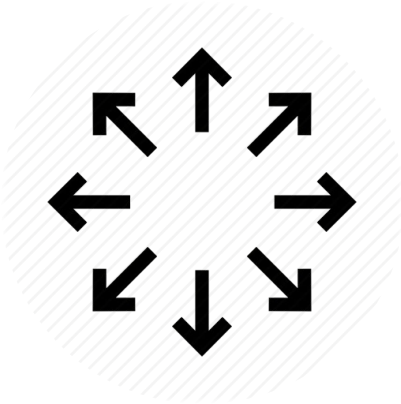
# Average sea level rise since 1900

**8 inches**
of sea level rise to date

=

**5 inches**
from land ice melting

+

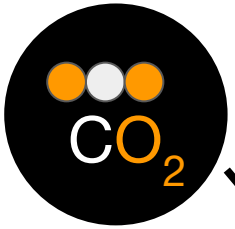


**3 inches**
from thermal expansion

Source: IPCC AR6 Table 9.5

# The Landscape of Climate Knowledge

## *Uncertain*




$CO_2$ Increase

## *Settled*

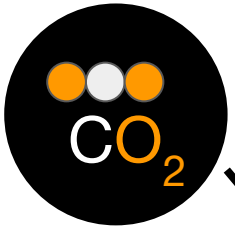
Average Temperature Increase

Heat Waves

Gradual Sea Level Rise

# The Landscape of Climate Knowledge

## *Uncertain*




$CO_2$ Increase

## *Settled*

Average Temperature Increase

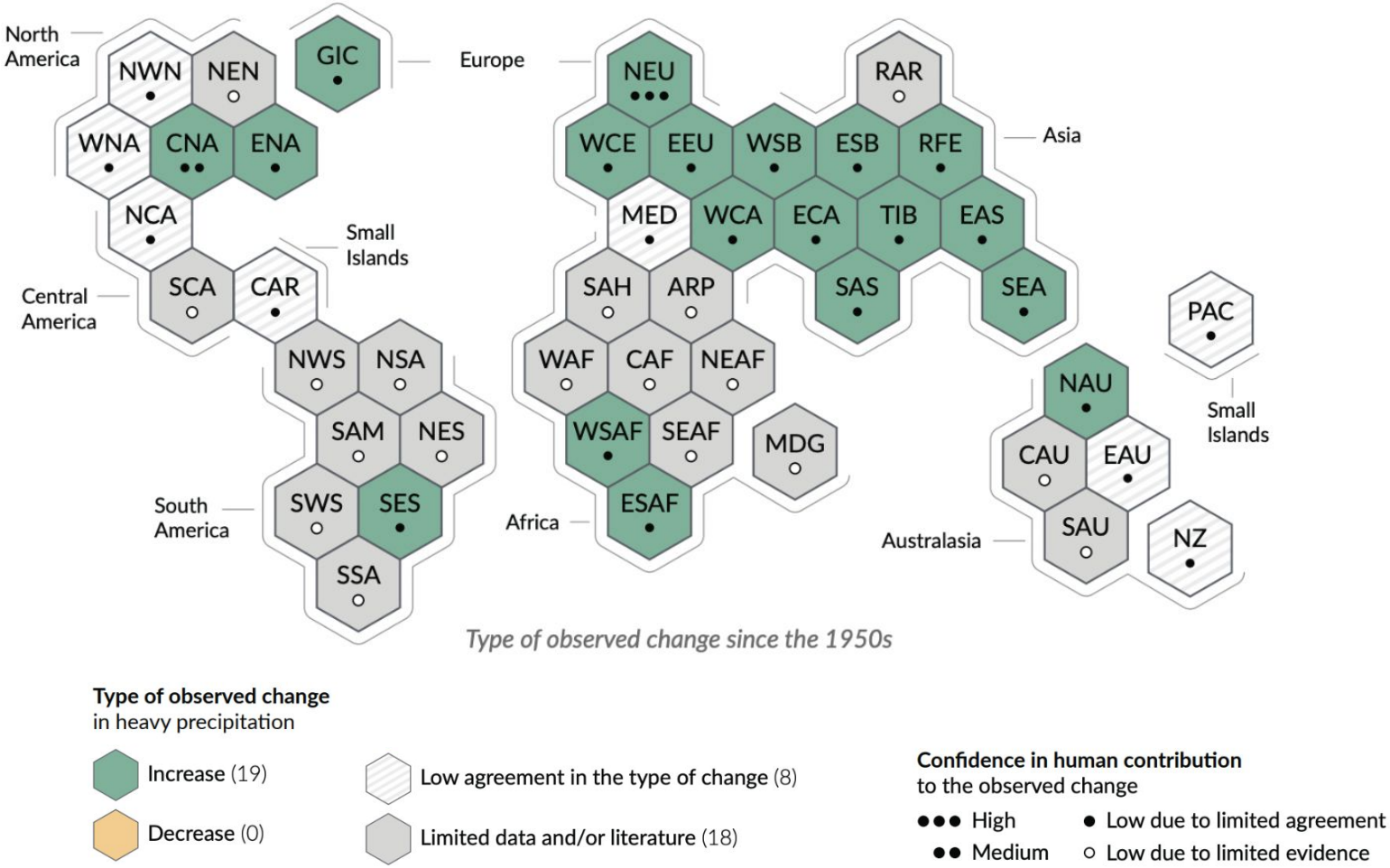
Heat Waves

Gradual Sea Level Rise

**Heavy rain is expected to intensify by 4% per °F.**

Damage from Hurricane Beryl in Monroe, NH

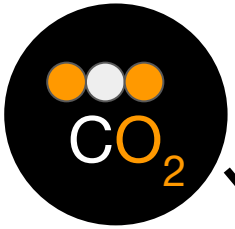
# Heavy rain expected to intensify by 4% per °F… but observed increases are hard to detect




Source: IPCC (2021), *Climate Change 2021: The physical science basis*. Figure SPM 3

# The Landscape of Climate Knowledge

## *Uncertain*




$CO_2$ Increase

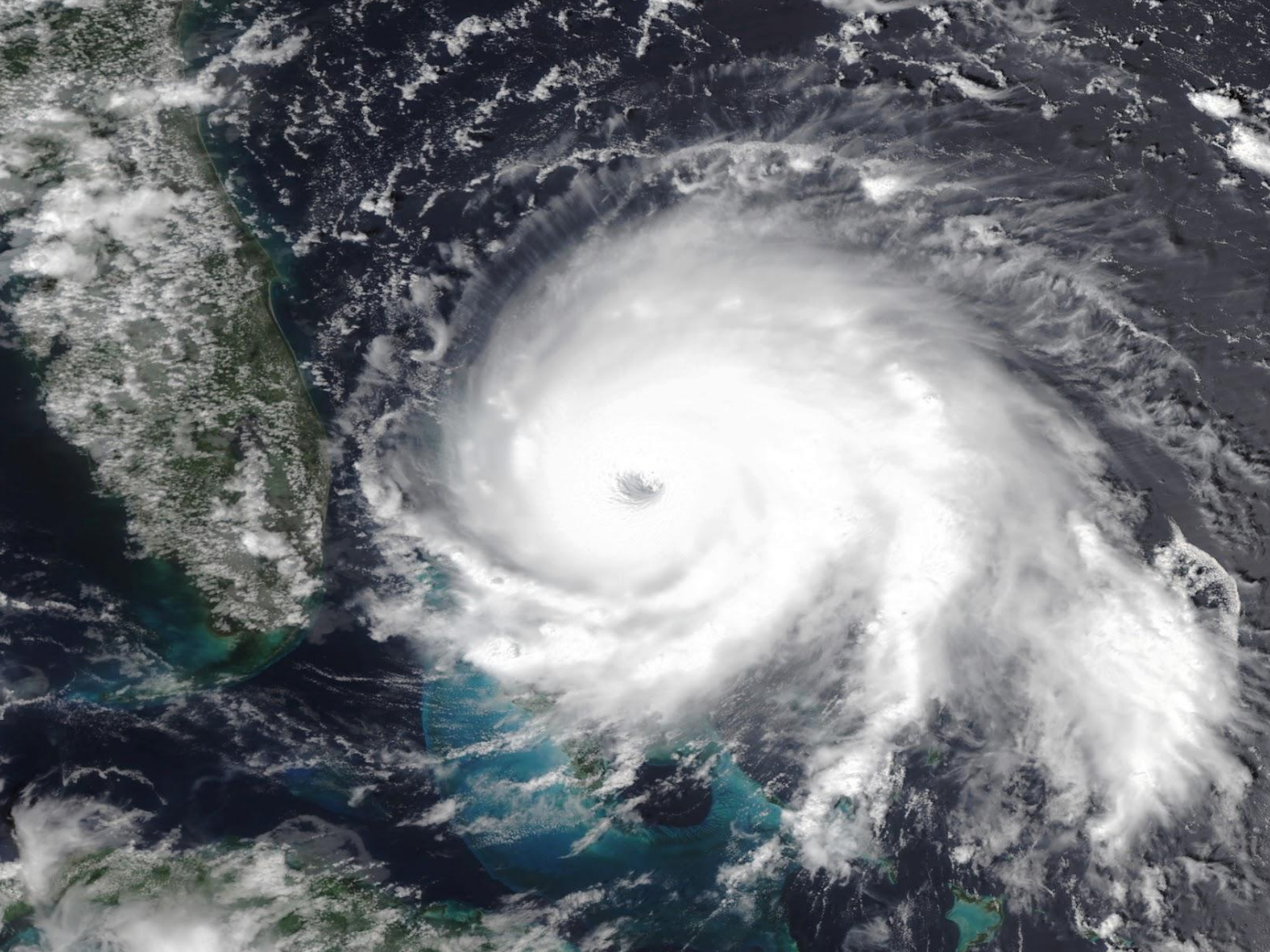
## *Settled*

Average Temperature Increase

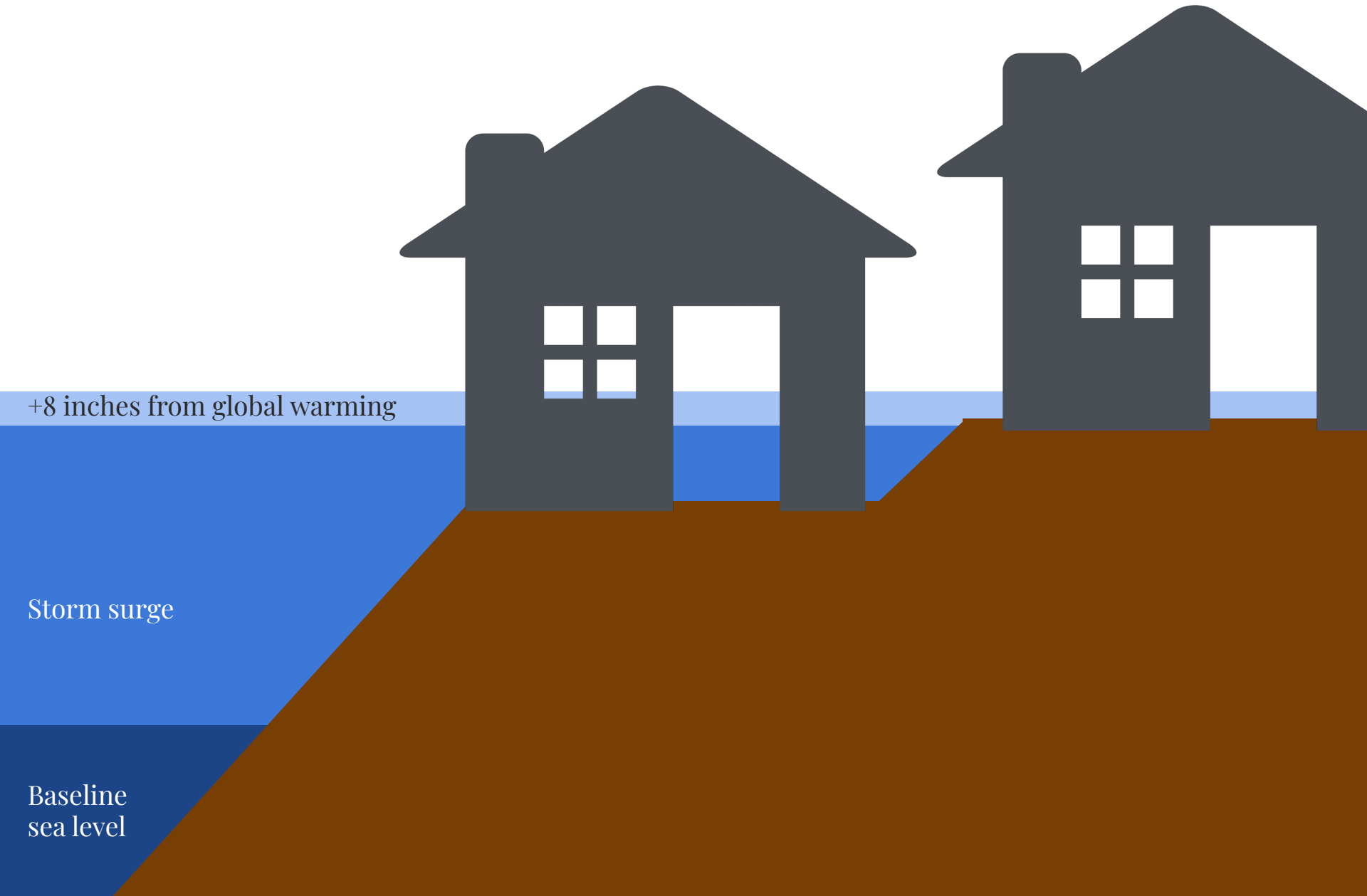
Heavy rain

Heat Waves

Gradual Sea Level Rise

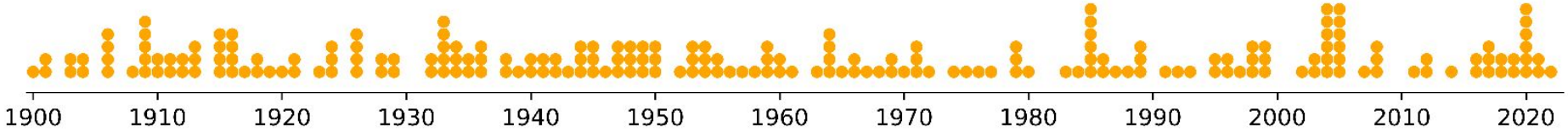


# Settled: Sea level rise adds to **storm surge**.



# Increases in hurricane activity have not been observed.

Landfalling hurricanes in the United States



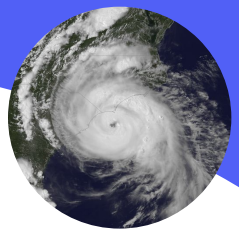

No significant change over time

Data source: HURDAT, National Oceanic and Atmospheric Administration – processed by Our World in Data

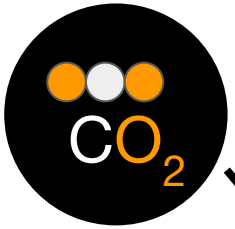

“Let us be clear: Hurricane Dorian has everything to do with climate change.”
- Senator Bernie Sanders, September 2019
Source: Twitter.com

# The Landscape of Climate Knowledge

## *Uncertain*



Hurricanes




$CO_2$ Increase

Heavy rain

## *Settled*

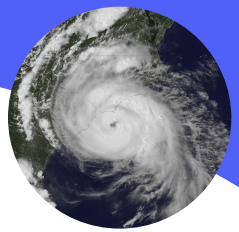
Average Temperature Increase

Heat Waves

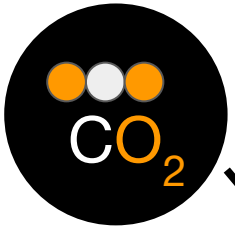
Gradual Sea Level Rise

# The Landscape of Climate Knowledge

## *Uncertain*



Hurricanes




$CO_2$ Increase

Heavy rain

## *Settled*

Average Temperature Increase

Droughts

Heat Waves

Gradual Sea Level Rise

Wildfires

# Tipping points?

## West Antarctic Ice Sheet collapse

"Poorly understood processes of instabilities, characterized by deep uncertainty" (IPCC)

## Permafrost "carbon bomb"

1-7% effect, "not enough to lead to a 'runaway warming' situation" (IPCC)

Source: IPCC AR6 WGI Chapter 9.4.2.4; IPCC AR6 WGI FAQ_Chapter_05 FAQ 5.2

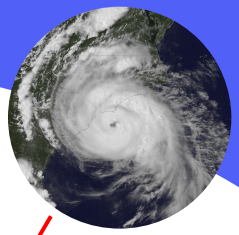
"The world is reaching the tipping point beyond which climate change may become irreversible."

—Kofi Annan, Former Secretary-General of the United Nations

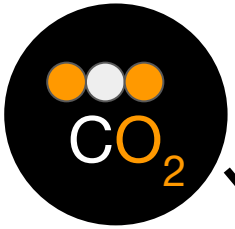
Source: The Guardian

# The Landscape of Climate Knowledge

## *Uncertain*



Hurricanes




$CO_2$ Increase

Heavy rain

Ice Sheet Collapse

## *Settled*

Average Temperature Increase

Droughts

Heat Waves

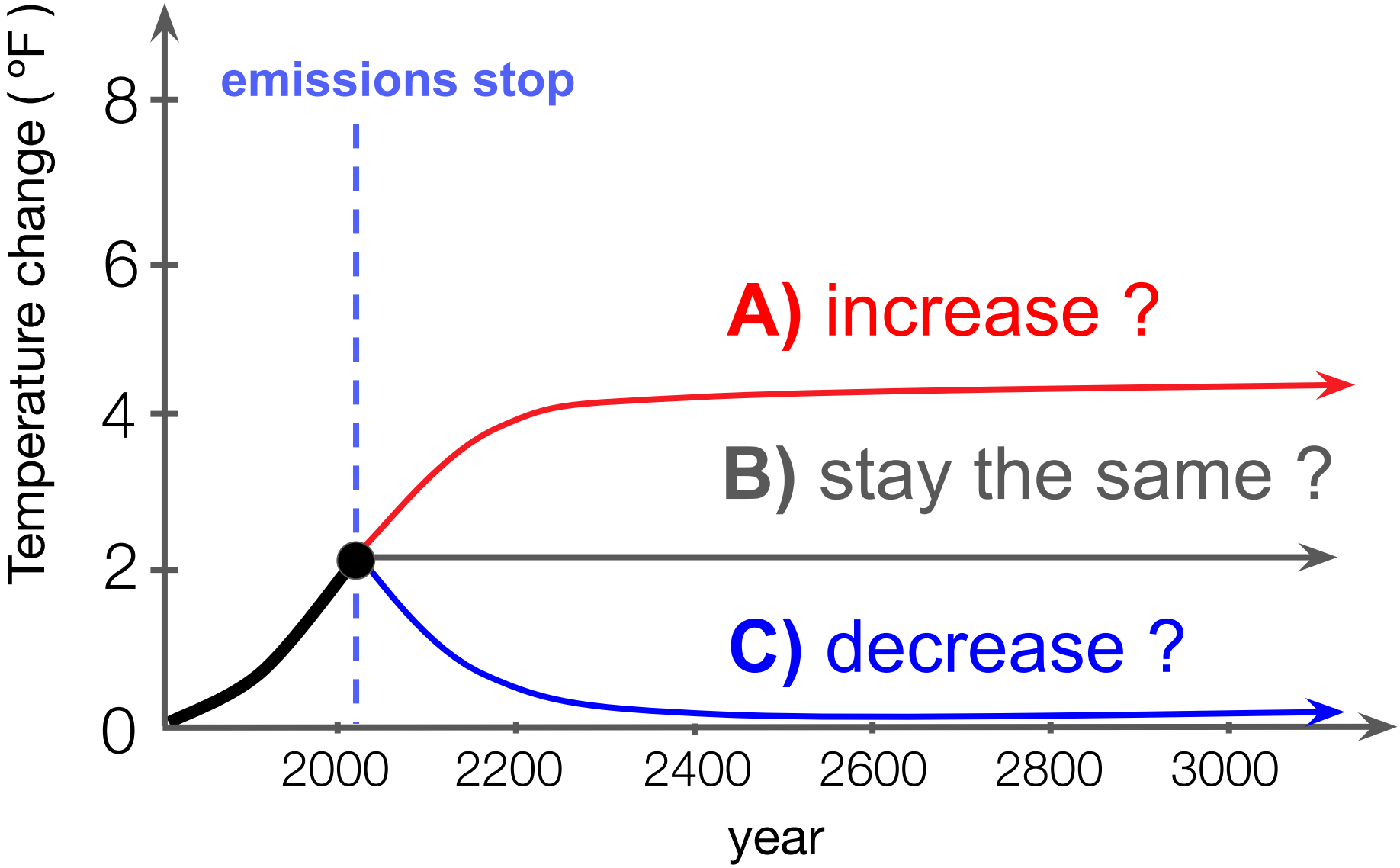
Gradual Sea Level Rise

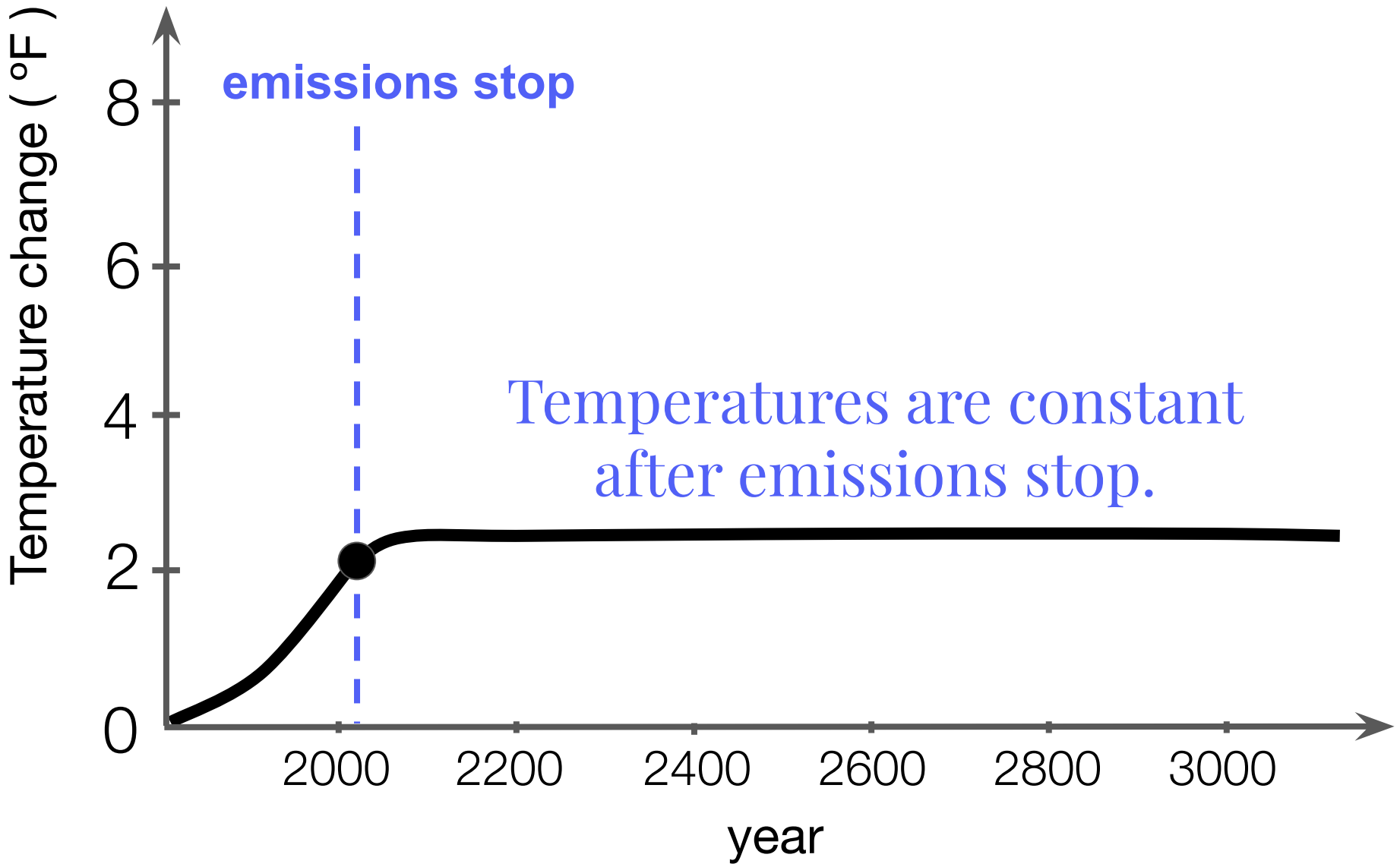
Wildfires

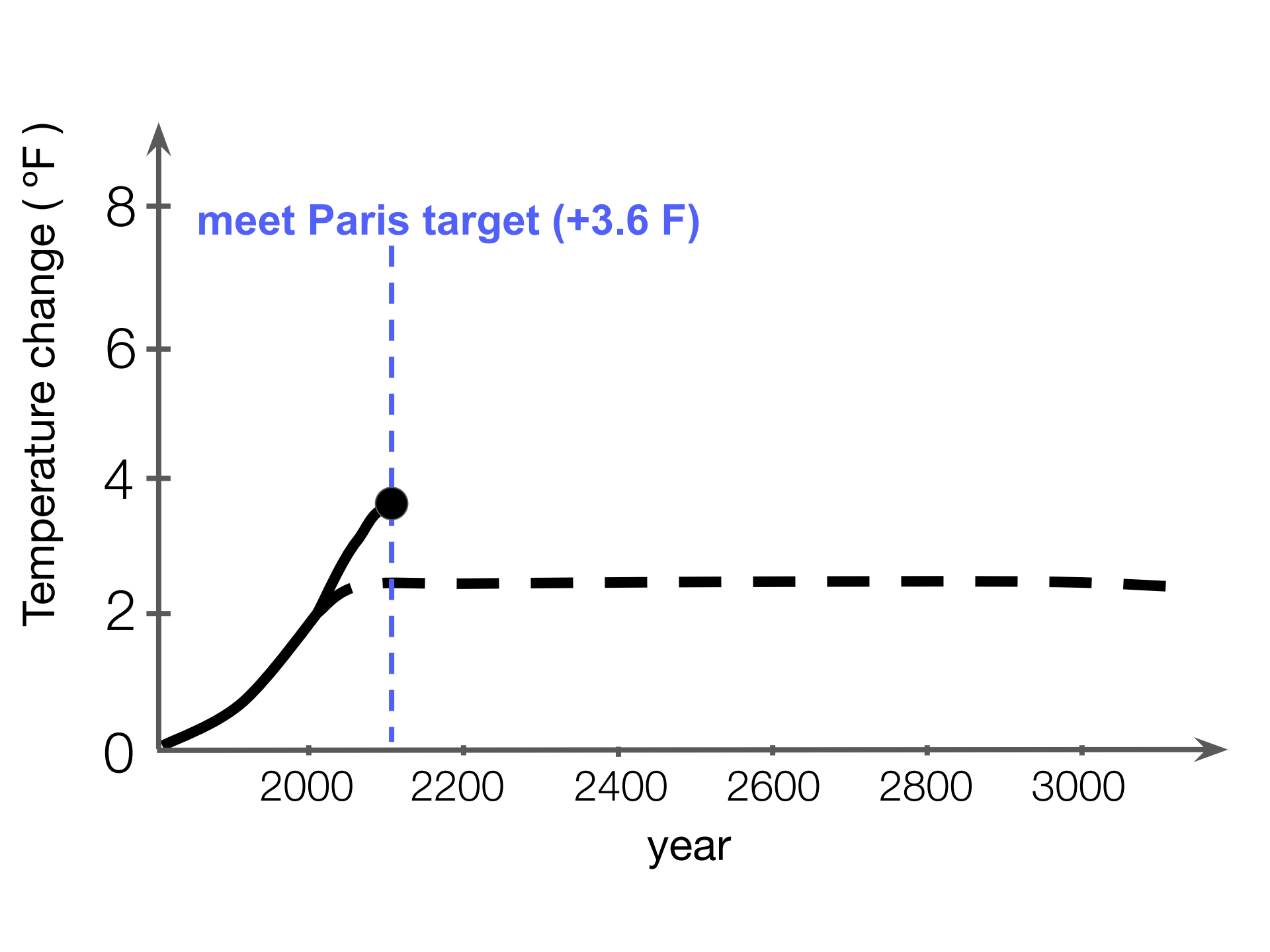
Permafrost Carbon Bomb

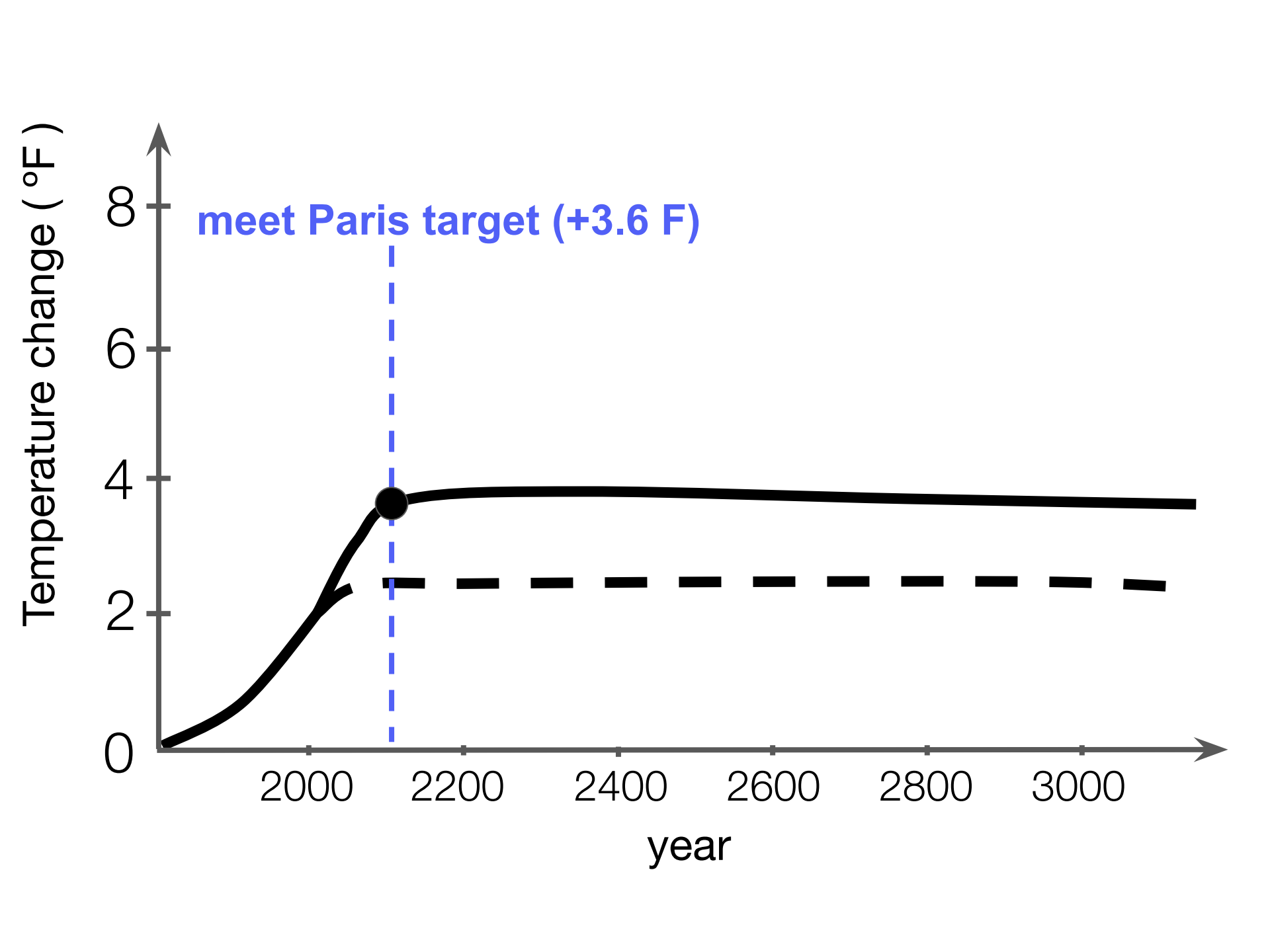
# How do our emissions shape future warming?

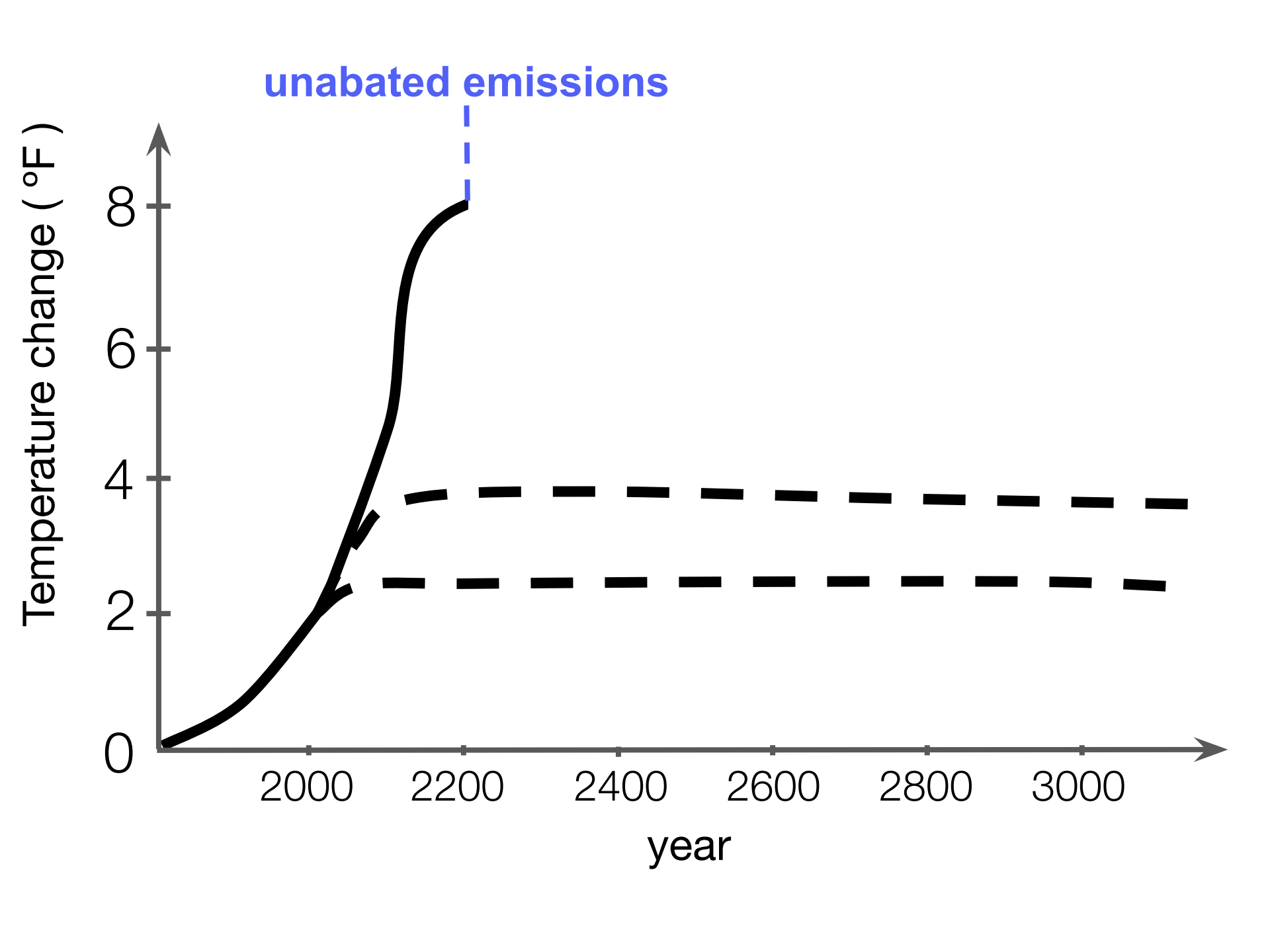
Q: If we stopped emitting $CO_2$ tomorrow, what would happen to global temperature?

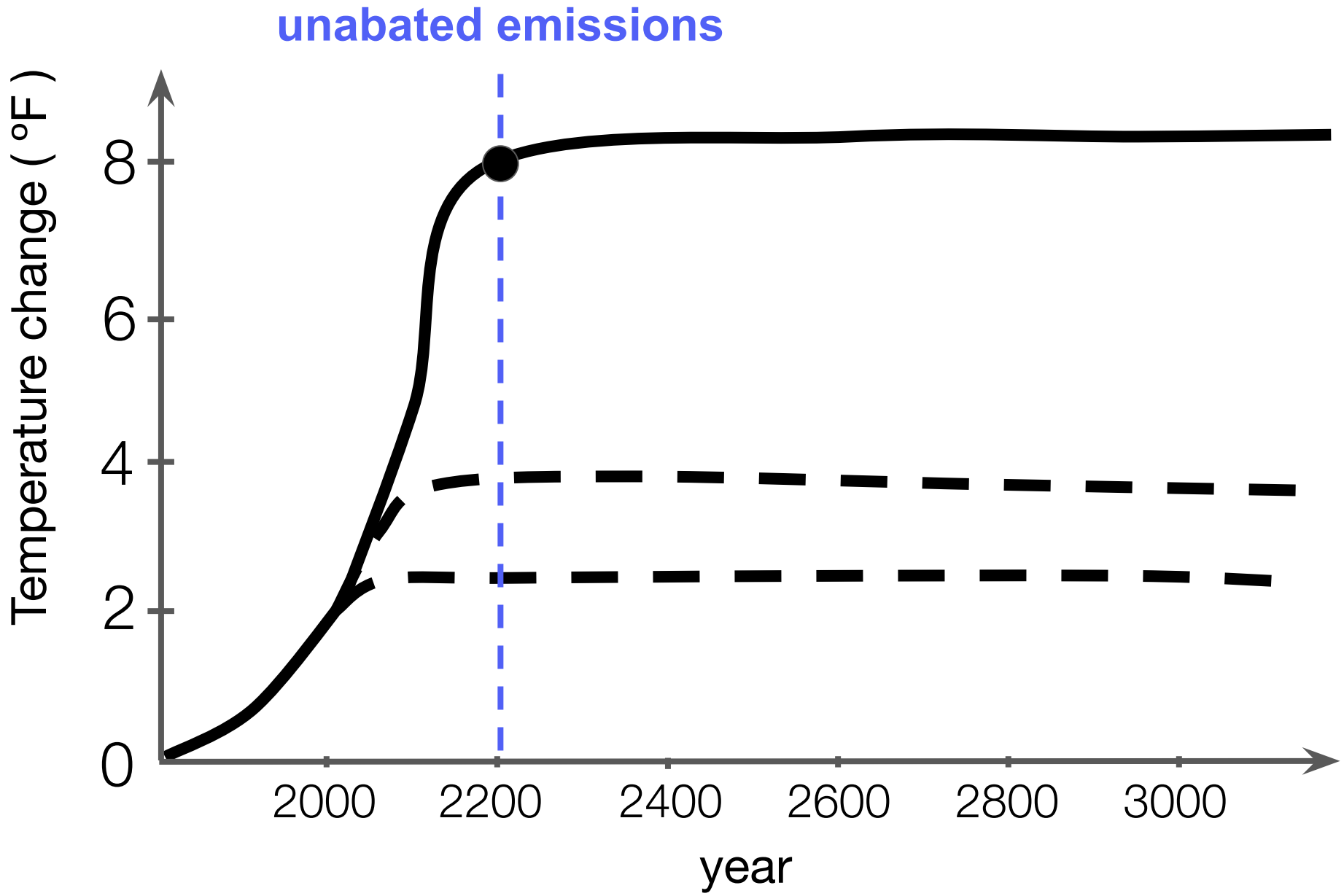

Temperature change ( °F )
8
6
4
2
0
emissions stop
A) increase ?
B) stay the same ?
C) decrease ?
2000
2200
2400
2600
2800
3000
year

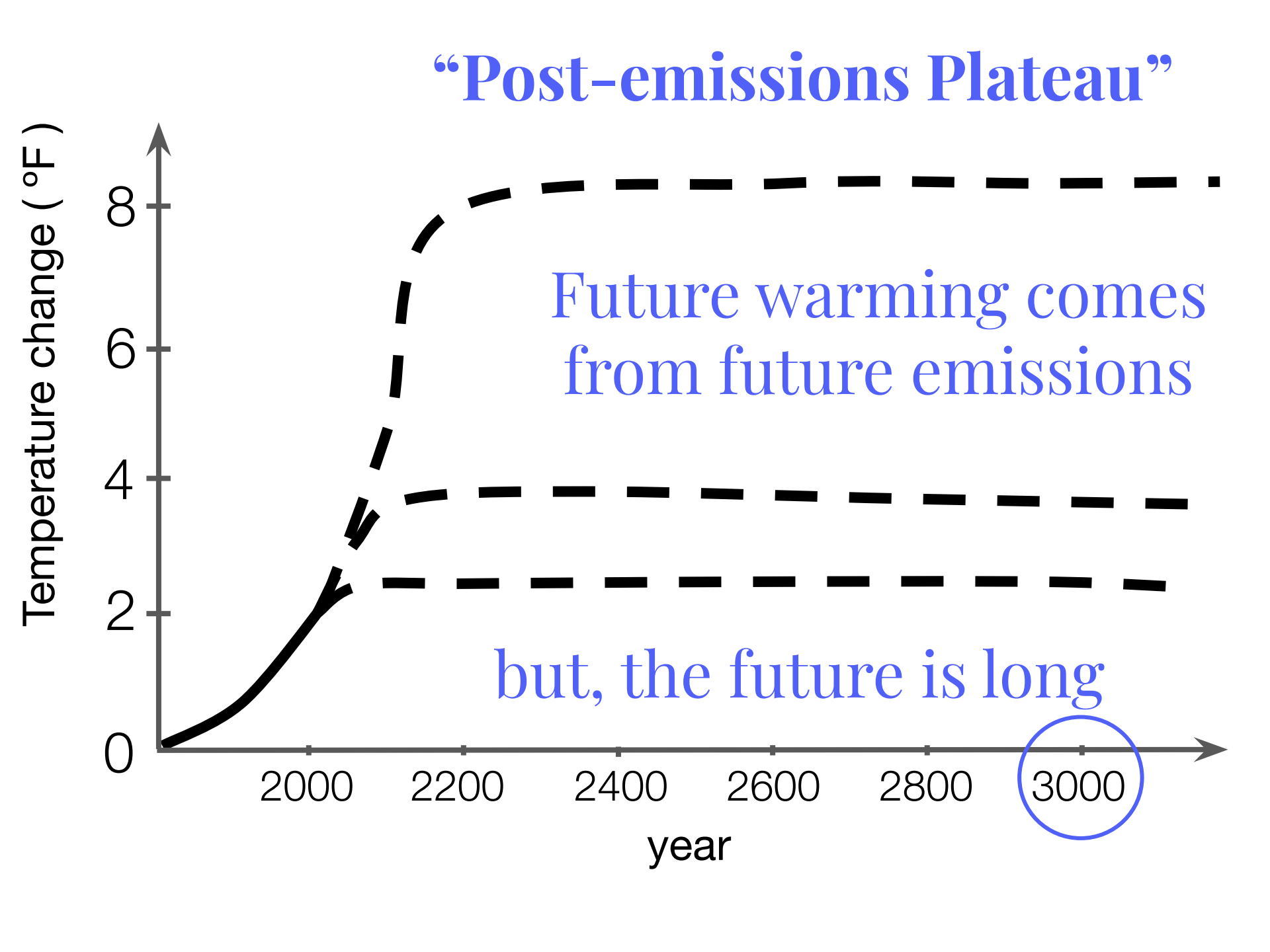

Temperature change ( °F )
0
2
4
6
8
emissions stop
Temperatures are constant
after emissions stop.
2000
2200
2400
2600
2800
3000
year


meet Paris target (+3.6 F)
Temperature change ( °F )
0
2
4
6
8
2000
2200
2400
2600
2800
3000
year

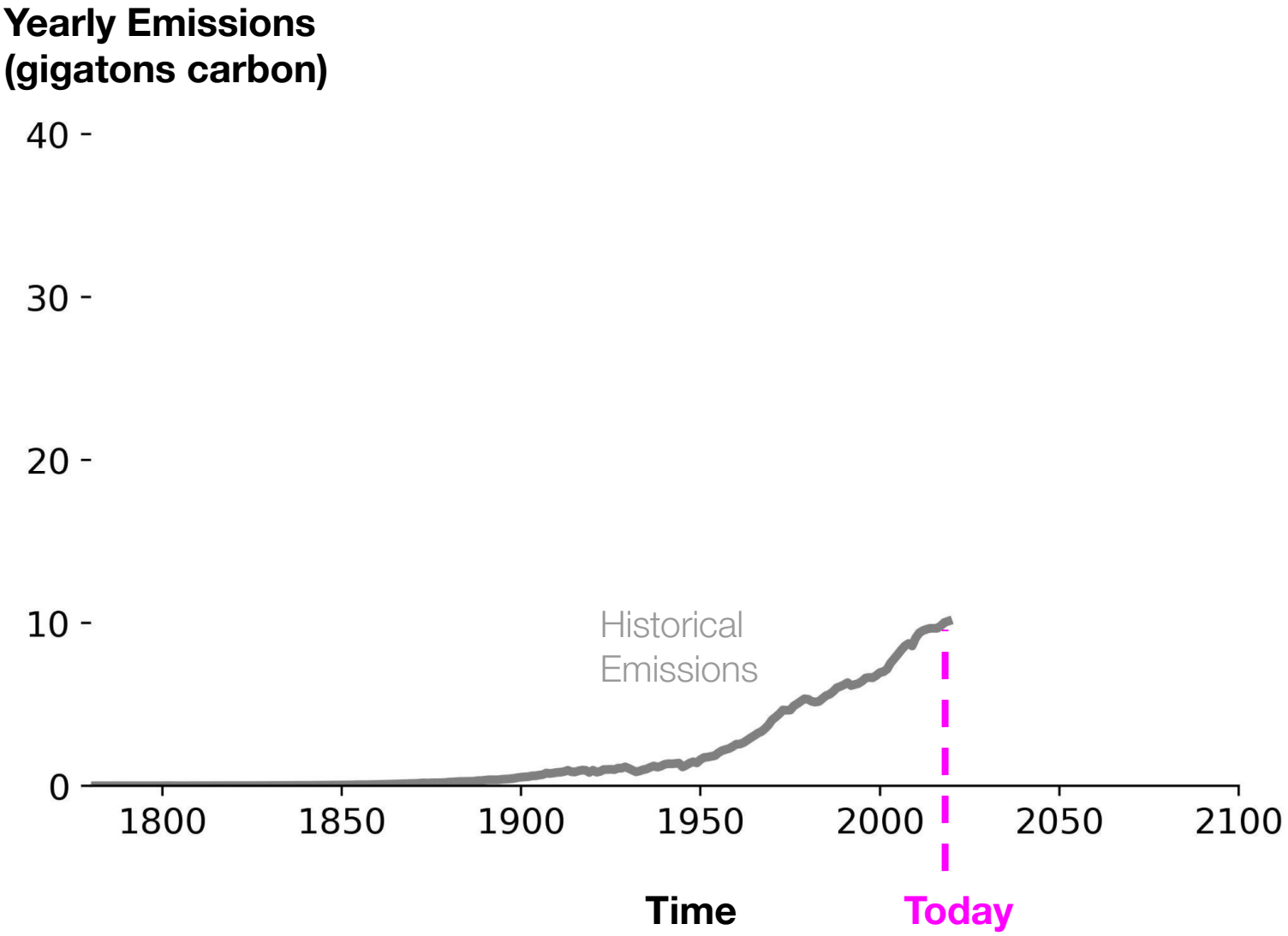

meet Paris target (+3.6 F)
Temperature change ( °F )
0
2
4
6
8
2000
2200
2400
2600
2800
3000
year


unabated emissions
Temperature change (°F)
8
6
4
2
0
2000
2200
2400
2600
2800
3000
year

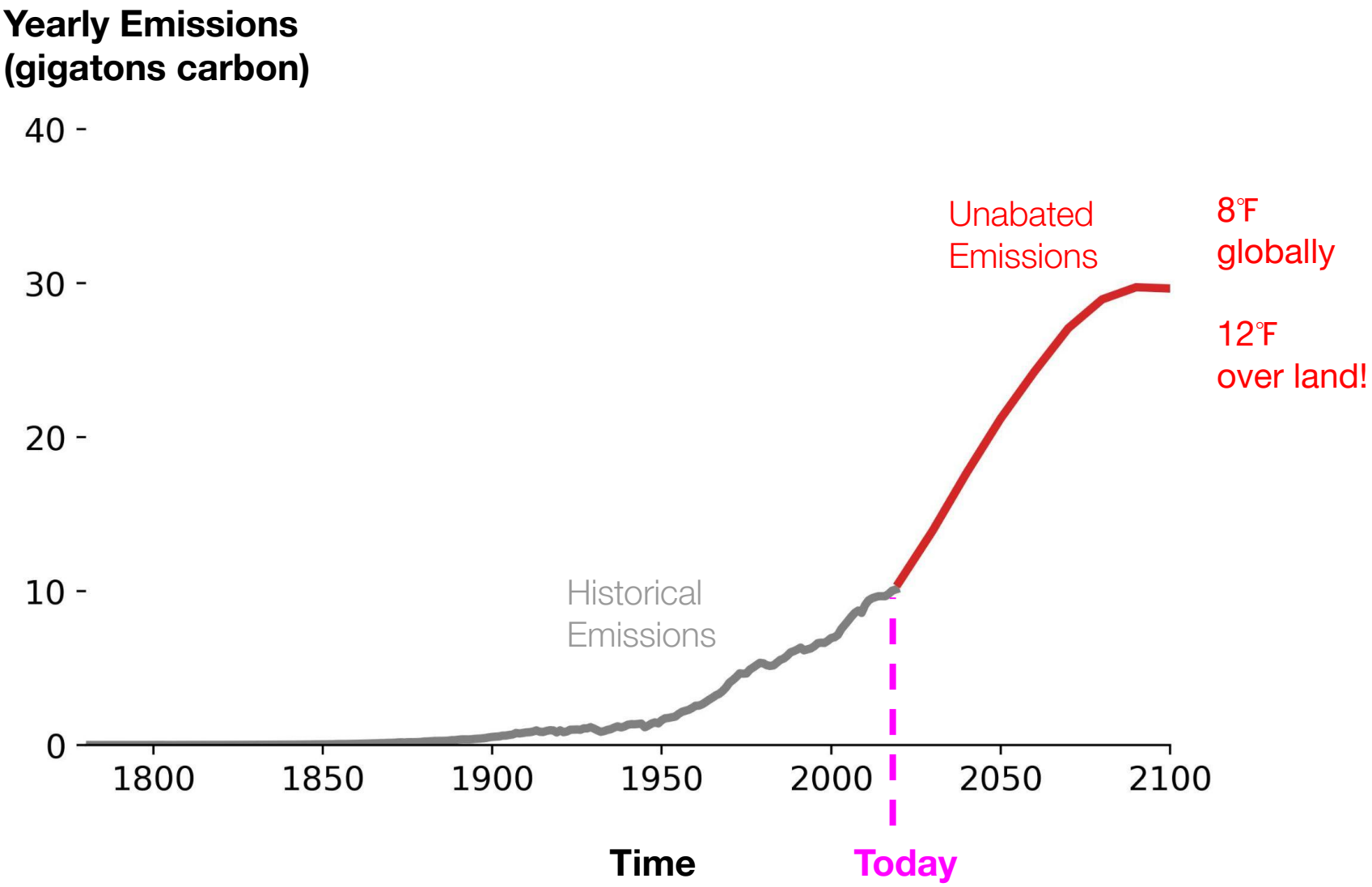

unabated emissions
Temperature change (°F)
0
2
4
6
8
2000
2200
2400
2600
2800
3000
year


"Post-emissions Plateau"
Temperature change (°F)
0
2
4
6
8
2000
2200
2400
2600
2800
3000
year
Future warming comes from future emissions
but, the future is long

# What could future emissions look like?

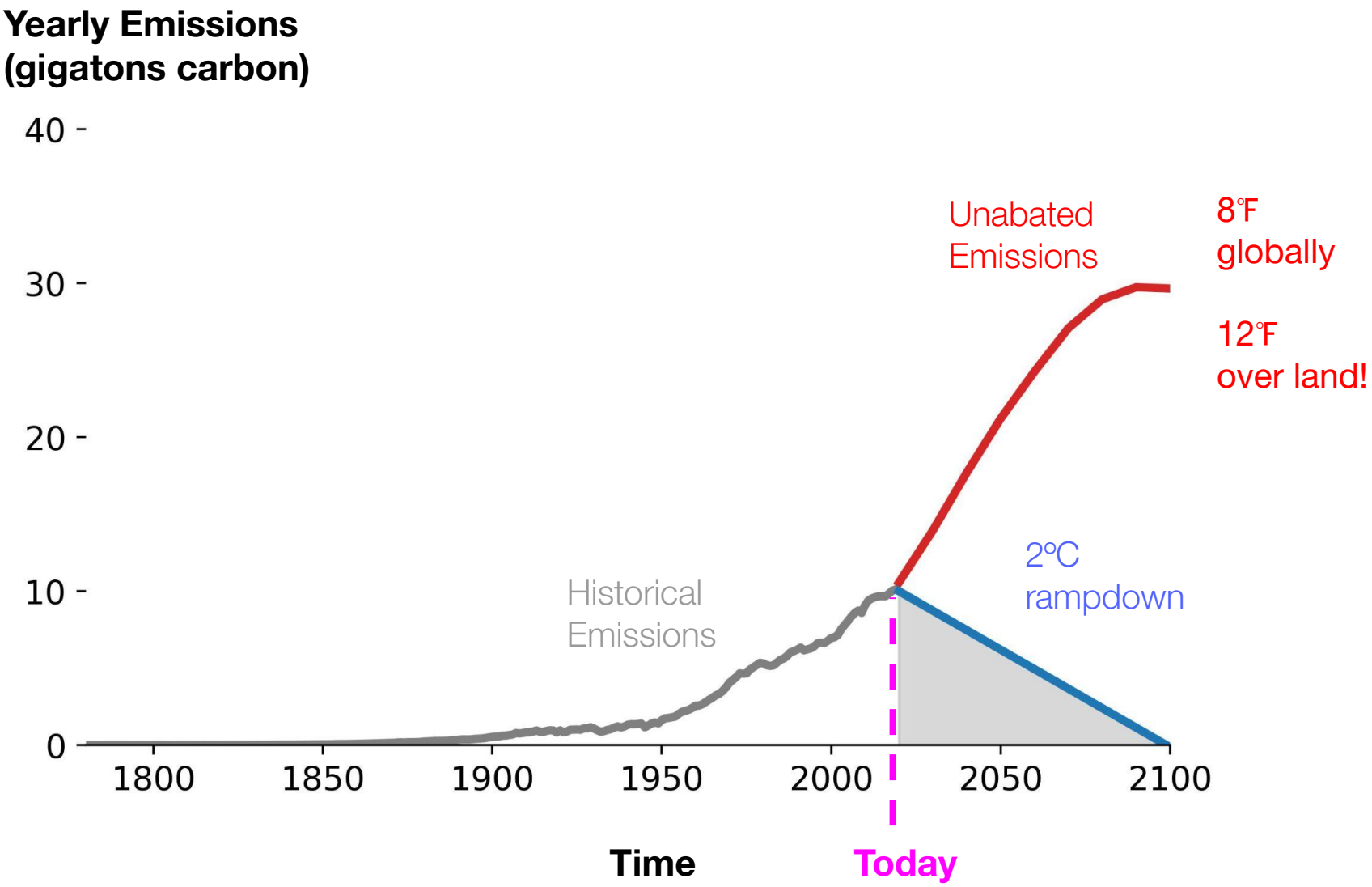


# What could future emissions look like?



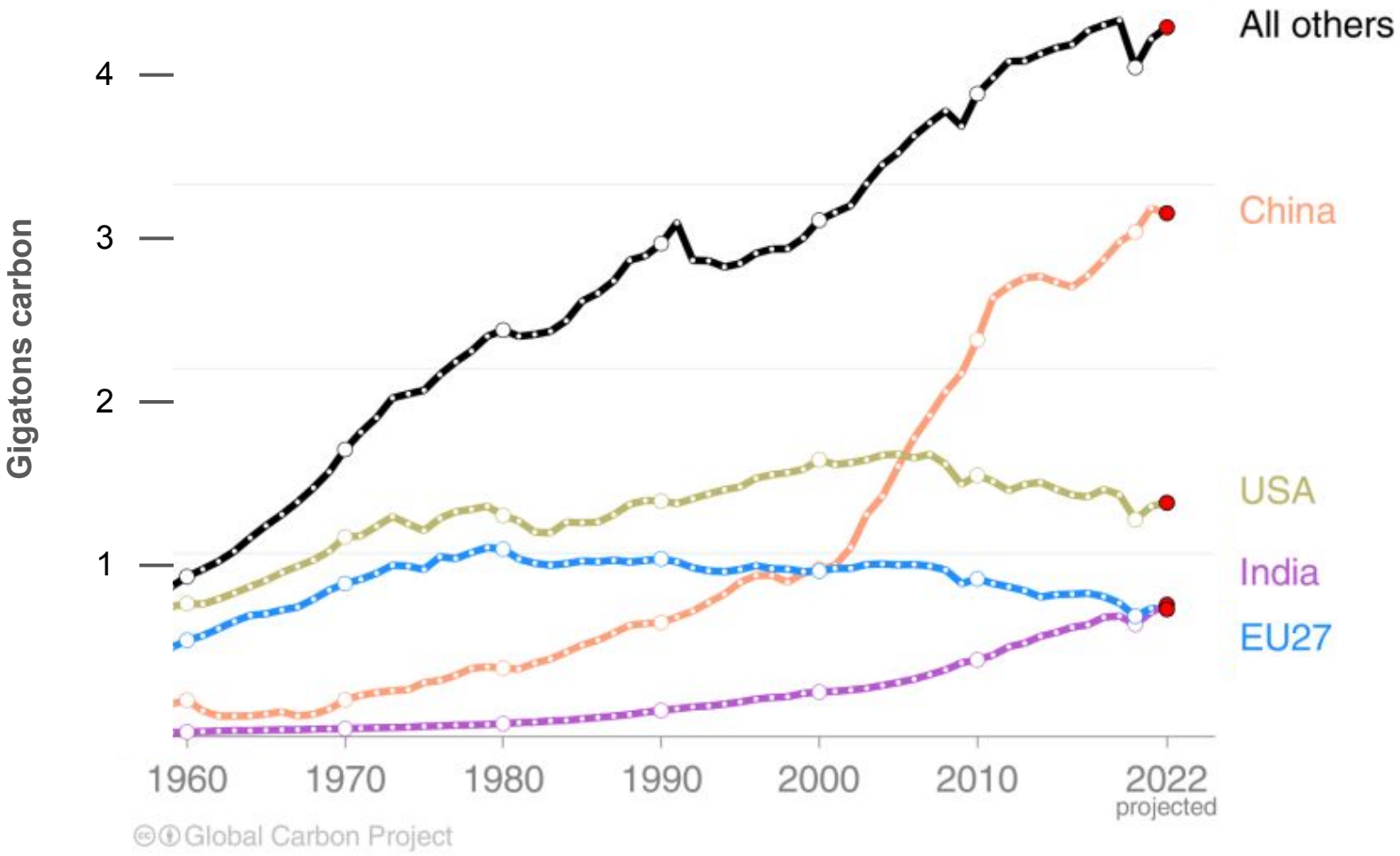

Source: Future unabated emissions are SSP5-8.5.
Global temperature estimate at 2100 for SSP5-8.5 is from Table 4.2 of IPCCAR6WGI Ch. 4

# What could future emissions look like?

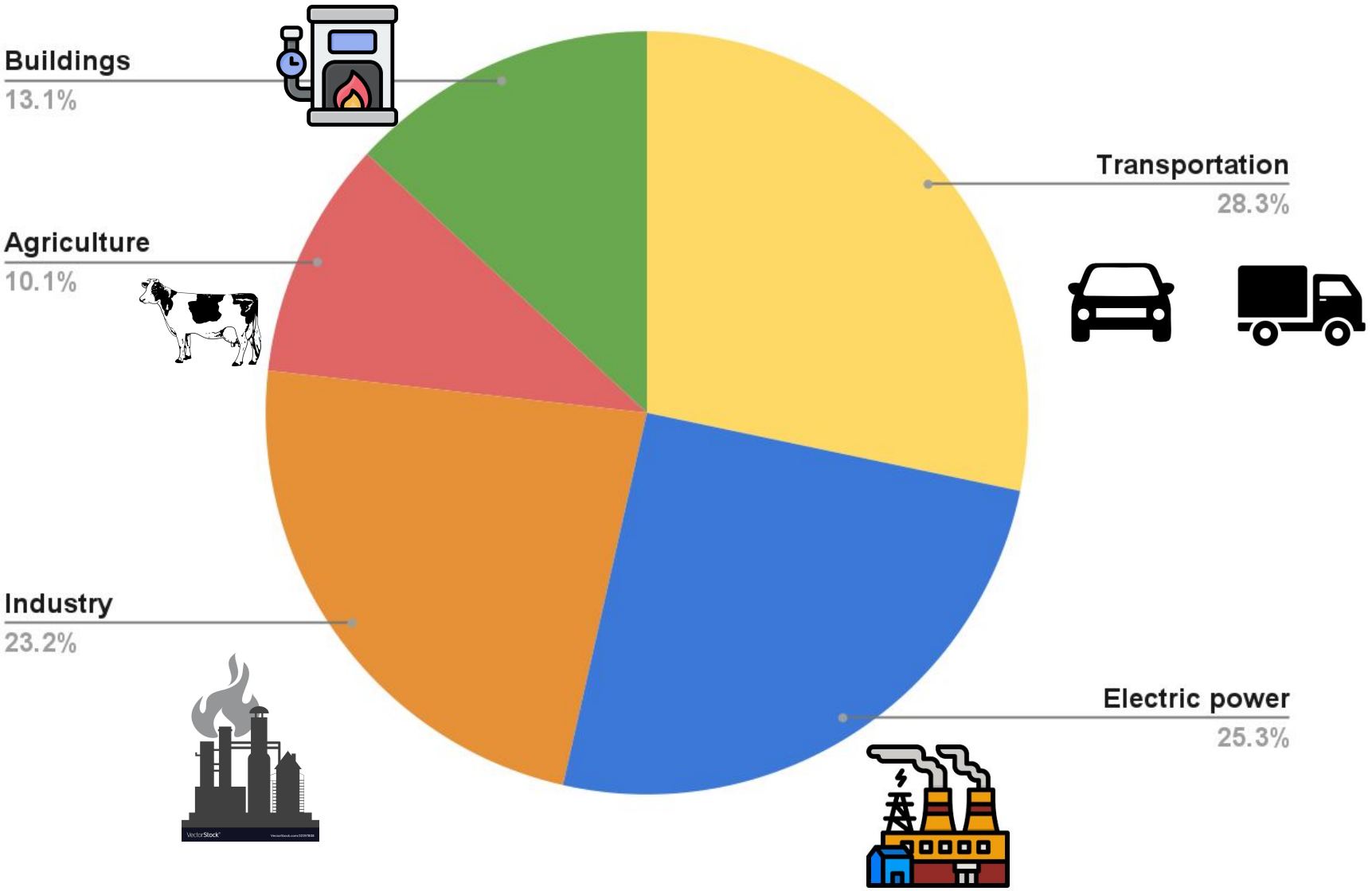



Source: Future unabated emissions are SSP5-8.5.
Global temperature estimate at 2100 for SSP5-8.5 is from Table 4.2 of IPCCAR6WGI Ch. 4

# Annual fossil $CO_2$ emissions

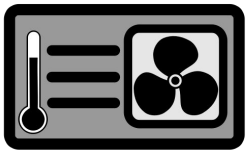


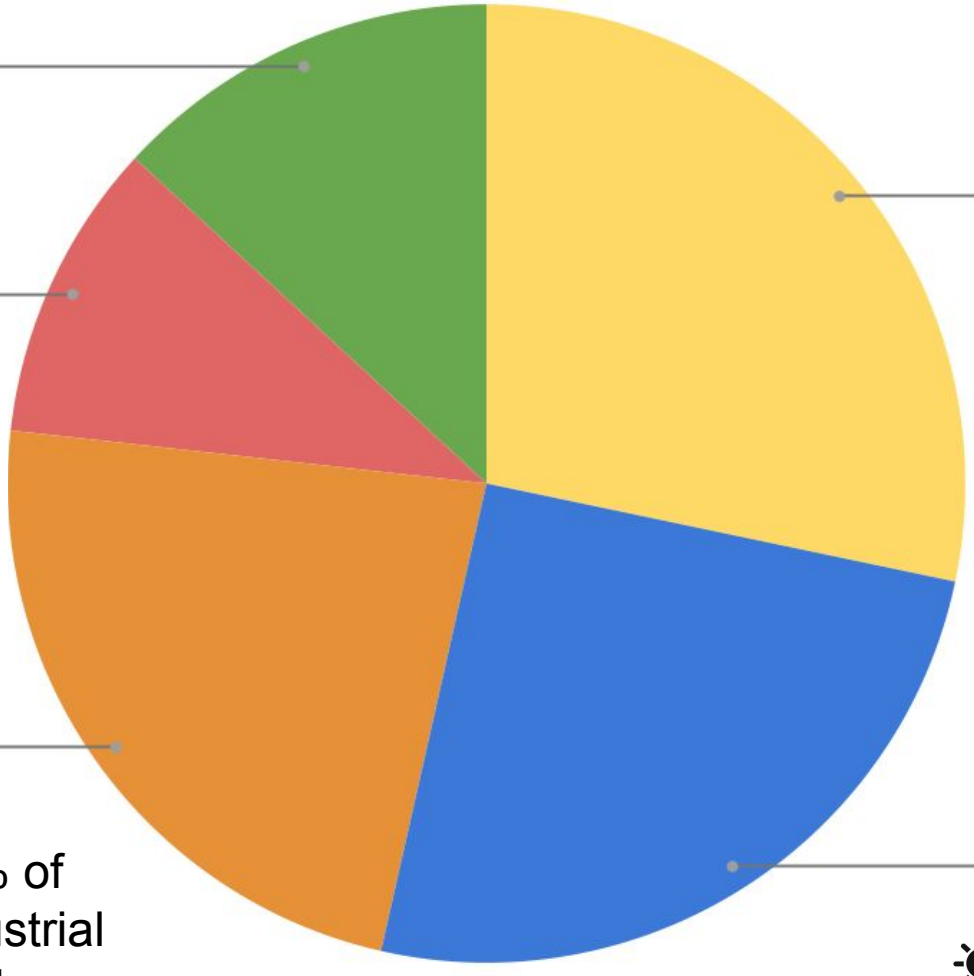
# U.S. $CO_2$-eq emissions

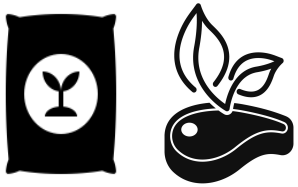



Source: EPA

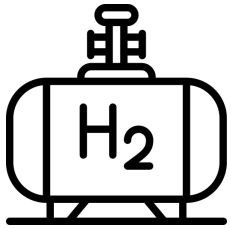
# U.S. $CO_2$-eq emissions





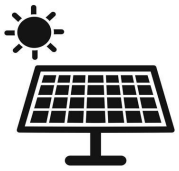



1% of fleet
7% of sales

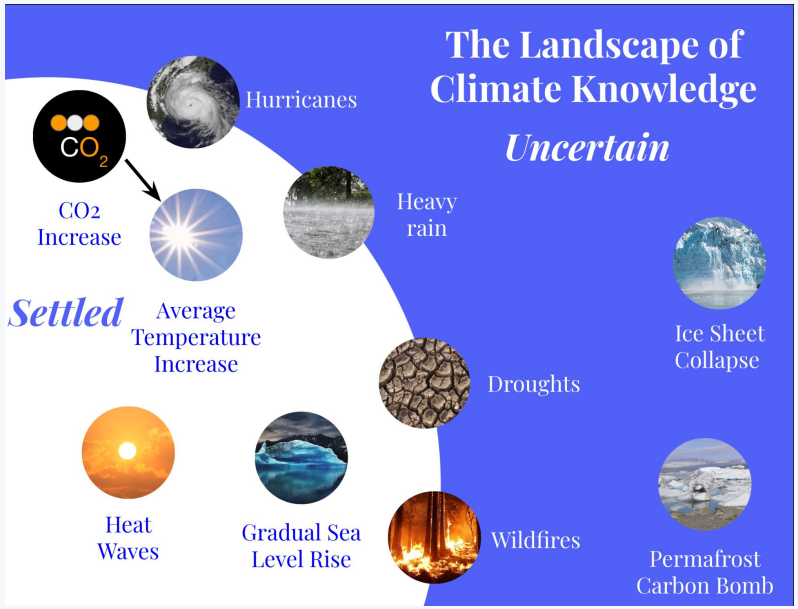



<1% of industrial heat

14% of grid



# Even when people agree on the scientific consensus:

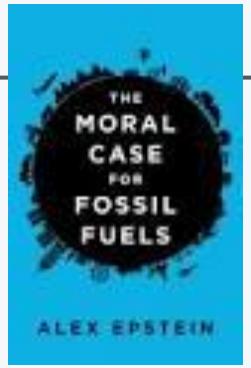


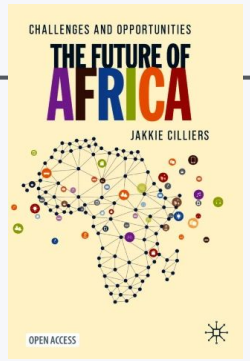

...they can still have differing views on what society **should do** about climate change.

# Policy choices depend on science *and* values

**Should developing nations rely on fossil fuels or renewables?**

Fossil fuels




Renewables

**Should we prioritize adaptation or mitigation?**

Adaptation

Mitigation

# Policy choices depend on science *and* values

## Mitigation policy: carrots vs. sticks?

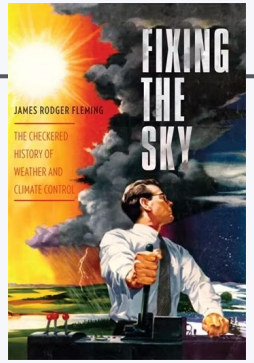
Regulations (e.g., fuel standards) — Carbon Tax — Carbon Cap and Trade — Consumer Subsidies (Inflation Reduction Act)

Sticks

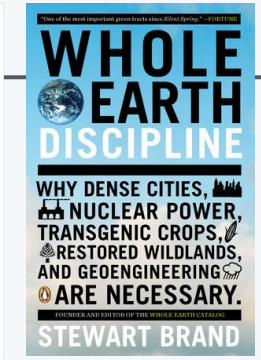
Carrots

## Should we "geoengineer" to offset global warming?

Anti geoengineering






Pro geoengineering


family

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# Help us build conversations that meet people where they are on climate science.

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## We are a 100% volunteer organization.

All donations go towards covering the travel expenses of Climate Up Close scientists on the road. We will provide you with an expense report, so you can see exactly how your donation enabled our outreach efforts.

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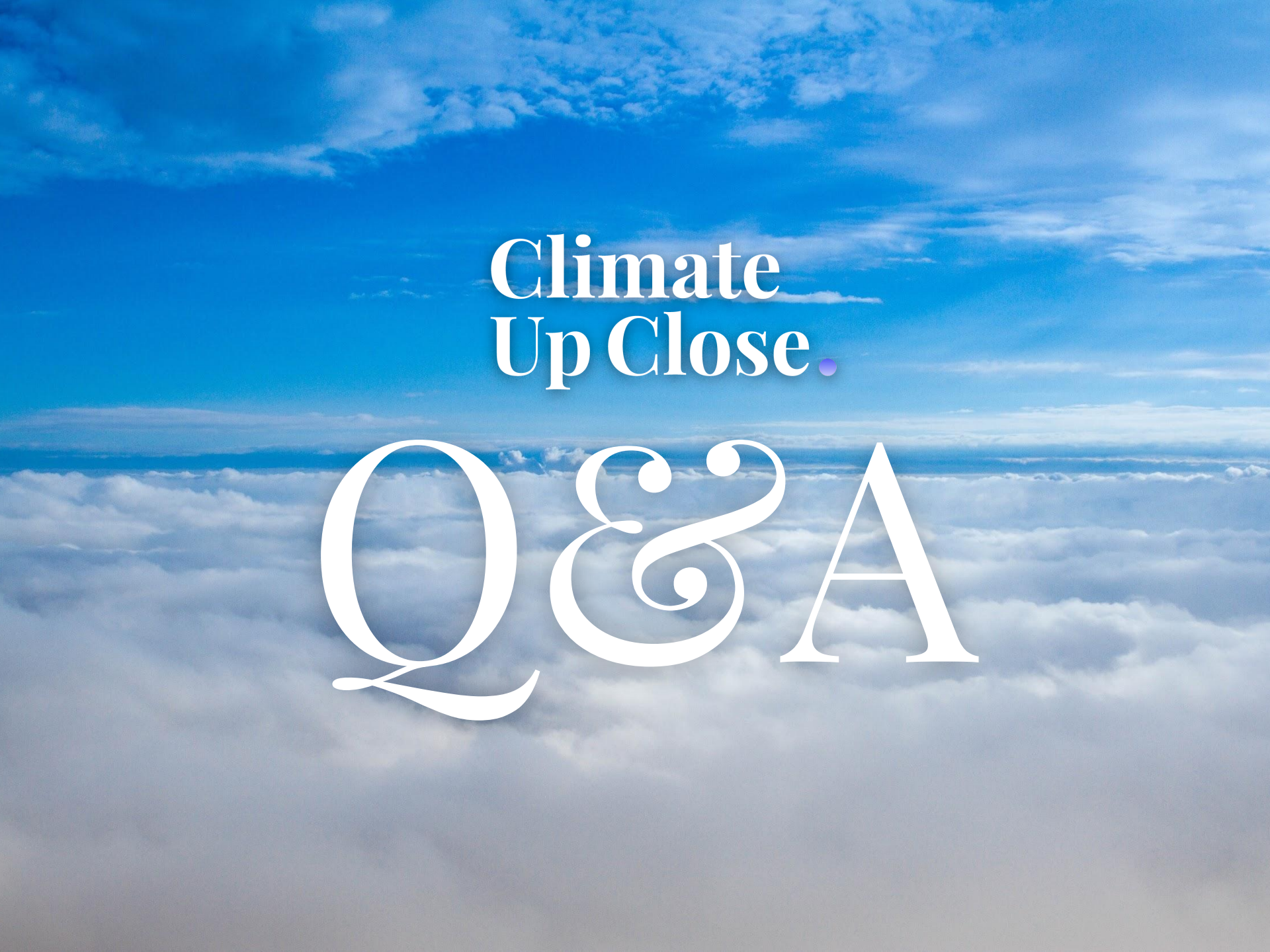
Climate
Up Close.
Q&A

# Climate Up Close. | Q&A

**Question Parking Lot:** Gilford Community Church

- What is some recommended reading?
- How did you all meet?
- Permafrost: Do they know how long the carbon has been there and how it got there?
- Glaciers/ice sheets: I've seen on TV where they have huge rivers in glaciers—could that help cause a breakoff?
- What is going to happen in the future related to the pollution that we're giving our planet—plastics, lithium battery waste?
- What about the CO2 absorbed by vegetation—what % is absorbed and how does that offset?
- I'm concerned that some of your studies are dated and some of the recent changes may indicate an acceleration.
- Looking at the scale, I remember seeing during Industrial Revolution huge chimneys. Why did emissions shoot up in last 20-30 years?
- Wildfires: Are they being exacerbated by climate change? If not, what's the cause.
- Droughts: Are they being exacerbated?
- Ozone layer: What's the latest? Is it connected to climate change?
- Are there some variables outside the scope of scientists' examination and analysis that aren't being considered, and could those variables be so significant they could turn everything on its head?
- What's the relationship between emissions and population growth?
- I'm encouraged by cease of emissions = temperature doesn't rise. If we stop, does carbon in atmosphere clear itself out?

Follow-up questions? Reach us at climateuc@gmail.com

# Climate Up Close. | Q&A

**Question Parking Lot:** Museum of the White Mountains

- Carbon capture: What role could you see it playing globally?
- Climate farms: No-cut trees. Largest single-tract one. Use for offsets. But also not getting money for forestry jobs.
- Cyanobacteria: How does global warming affect cyanobacteria in lakes and ponds? Big storms, lots of runoff.
- I'm curious about the switch to electric vehicles and the climate impact of the mining that goes into making those batteries.
- To add to that (EV) issue, the cost & emissions of disposal/recycling…?
- What can we do to reduce the consumption of electricity by creation/maintenance of cryptocurrency?
- What's the biggest bang for your buck to bring down carbon emissions?
- What would you say to the average citizen of average education on how they can make a difference (at the individual level)?

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# Climate Up Close. | Q&A

**Question Parking Lot:** Squam Lakes Natural Science Center

- I'm glued to the Weather Channel. High temps in ocean: It's hard to believe there's any way to lower those temps. What happens next?
- *What about tornado frequency?*
- In this area, clear heat waves, but also reduction in cold spells in winter—is that true?
- *What about Clathrates?*
- *What is the inflection point/slope of curve change in 1960s?*
- *Could you talk about number of parameters in model and fit/tuning?*
- *Has climate change made hurricanes more intense? An MIT person said yes.*
- Could you touch upon ocean current changes?
- *Could you talk about methane plumes from the ocean floor?*
- I've heard geoengineering could be calamitous—what are your thoughts?
- Could you talk about impact of temp rise on food supply and what happens to farming in U.S.
- I've heard climate change makes extremes more extremes: does that muddy the conclusions around different extreme events?
- Is there a difference in intensity of different greenhouse gases—exhaust from an automobile, cows, woodsmoke, etc.?
- *Why was weather in 1930s so extreme?*
- For the extreme precipitation, you have guidance like 4% per degree—is there more guidance like that for infrastructure to withstand extremes?
- *Transportation: Do you believe that EVs will reach a day when they will go net positive (total emissions from embodied production plus emissions) and if so how?*
- *What's the impact that has been observed/settled about observed temp rise/projections on ecosystems. And how that will influence phenology of plants blooming and if that's impacting wildlife, migration patterns—not just on land but also in sea. Gulf of Maine challenges*

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# Climate Up Close. | Q&A

**Question Parking Lot:** Starr King Unitarian Universalist Fellowship

- Methane: I'm a little confused, also EDF pinpointing where methane coming from. Higher concentration—how important is methane control, and how much of the pie is it? Also more of it in the Arctic?
- Based on the heat wave hex map, looking at E and C US as not having enough data and consensus—why don't we? How can U.S. not know?
- Can you talk about changing ocean currents as a tipping point and what that means for fisheries?
- Re: Heat hex map: Do we not have enough info due to political policies in those areas? Need more data given amount of change occurring?
- I read about craters in South Siberia from land melting—can you speak to that?
- Can you speak to how AI is contributing to climate change? (Data centers, etc.)
- Are there ways that conservation may help climate change when it comes not only to animals but also resources and atmosphere—esp. Deforestation and industrial pollution?
- I heard that a Bay in Maine is warming faster than any other part of the ocean, if so, why?
- I've heard of a 22,000-cycle Ice Age. Is that happening or not?
- Sea level rise: Is that also happening in lakes given that water is expanding?
- Human CO2 emissions: The grey area of uncertainty was larger in previous parts. Why?
- You presented plateau as fact: I find that hard to believe.
- Do you have suggestions on a local level for what we as citizens can do to help mitigate the problem?
- You mentioned that ice sheets and permafrost are unsettled—what would take for it to be unsettled?
- Earthquake, thunder, lightning, public safety—are these settled, etc.?

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# Climate Up Close. | Q&A

**Question Parking Lot:** Temple Beth Jacob

- The decline in CO2 emissions in the U.S.—isn't that misleading, as industry has been outsourced to other countries?
- Could you talk about AMOC and its possible slowing? 2057 for it to stop?
- Why is the heating that is occurring over the Arctic so much greater than that over the Antarctic?
- What did we learn at the start of the pandemic when transportation was drastically cut?
- Can you talk about droughts and wildfires?
- I hear so much negativity and doom and gloom, but what's something you're excited to see on the horizon in your scientific study?
- It seems there are lots of European countries ahead of us in what they're doing (wind power, etc.)—what is it going to take for us to advance?
- As research scientists, how do you guard against your own biases when doing this research? When applying for funds, how do you make sure it doesn't alter your results?
- You called out politicians for overstating things. As climate scientists, what do you see as the role of politicians and policymakers as opposed to yours? Do books like Ministry for the Future advance the conversation?
- One of our favorite pastimes in NH is politics and being first in the nation. If you were able to be a part of conversation with Presidential candidates, what would you ask?
- One often hears that scientists underestimated the risks of climate change—what would you say about that?
- As a plant scientist, I've heard not only about extreme heat events and droughts but also extreme cold fluctuations—what does the science say about that globally?
- There's a lot of fires going on—how much does that change the CO2 levels?

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# Climate Up Close. | Q&A

**Question Parking Lot:** Unitarian Universalist Church of Franklin

- Peter Zion: Gripe about solar panels: Carbon footprint in melting aluminum frames, offsetting benefit. To what extent is that true?
- I am for renewable energy, but I've wondered about taking energy out of the wind, from solar, from geothermal—is there any unforeseen consequences of those down the road?
- I'm interested in what individuals can do (if it really matters)—what are 1-2 main things individuals can do in their lives?
- In your models: How methane contributes, especially in comparison to CO2?
- Could you speak about what the Paris Agreement entails? Are there other international talks going on that might involve entire global community?
- What personal changes have you all made in your lifestyle in addressing climate change?
- Could you talk a bit to what policy changes you see in the works that may affect these things?
- EVs: Batteries, embodied carbon costs? Benefit vs. costs?
- Curious to know which orgs are working on the uncertain section—how can we support/get involved?
- What would be your priority list as far as we as individuals could do and as a society to improve situation?
- Curious about the cloud seeding—is there activity in doing this for climate change?
- I've wondered whether it's better to drive 1000 miles to go to a protest on climate change vs. stay home?

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