

Presented to EEB Seminar, 29 Sept. 2020, 12-13h

Sea Level Rise



[7/62]

A damaged ferry boat sitting in shallow water in Providence, R.I., following the deadly hurricane of 1938 that hit the Northeast. (AP Photo/Boston Public Library, Leslie Jones)



[15/62]

Westminister Street from Eddy to Market Square was under several feet of water after Hurricane Carol paid a destructive visit on August 31, 1954. [Providence Journal files]

Baylor Fox-Kemper
Brown University

Earth, Environmental & Planetary Sciences

Institute at Brown for Environment & Society

My research?



from global to universal

We study the physics of the ocean and how the ocean fits into the Earth's climate system, using models that range from the global scale to focused process models that apply universally. We seek mathematically interesting problems with practical uses.

The products we produce are parameterizations, diagnostics, and toy models. That is, after study of complex processes in dedicated and computationally expensive models, we work out simple but accurate approximations and crucial measurements to diagnose. Sometimes the goal is to improve the community models, and sometimes the goal is to aid understanding with a toy model that mimics the complex system.

The IPCC? WGI?



The Intergovernmental Panel on Climate Change (IPCC) provides regular assessments of the scientific basis of climate change, its impacts and future risks, and options for adaptation and mitigation.

Created in 1988 by the World Meteorological Organization (WMO) and the United Nations Environment Programme (UNEP), the objective of the IPCC is to provide governments at all levels with scientific information that they can use to develop climate policies.

Me & the IPCC?



For 3 years, I've been a Coordinating Lead Author of the Working Group I (scientific basis of climate change), Ocean, Cryosphere, & Sea Level Change Chapter of the IPCC Sixth Assessment Report.

IPCC Special Report on The Ocean and Cryosphere in a Changing Climate was released in Sept 23, 2019.

Our report will be released in 2021-2022. Our chapter is being written by 3 CLAs, 14 LAs, 3 REs, >44 CAs, and 5 Chapter Scientists. The AR6 WGI has 232 CLAs & LAs; the whole report has 721.

As a CLA, I'll help write the Policymaker Summary and the Technical Summary, and...

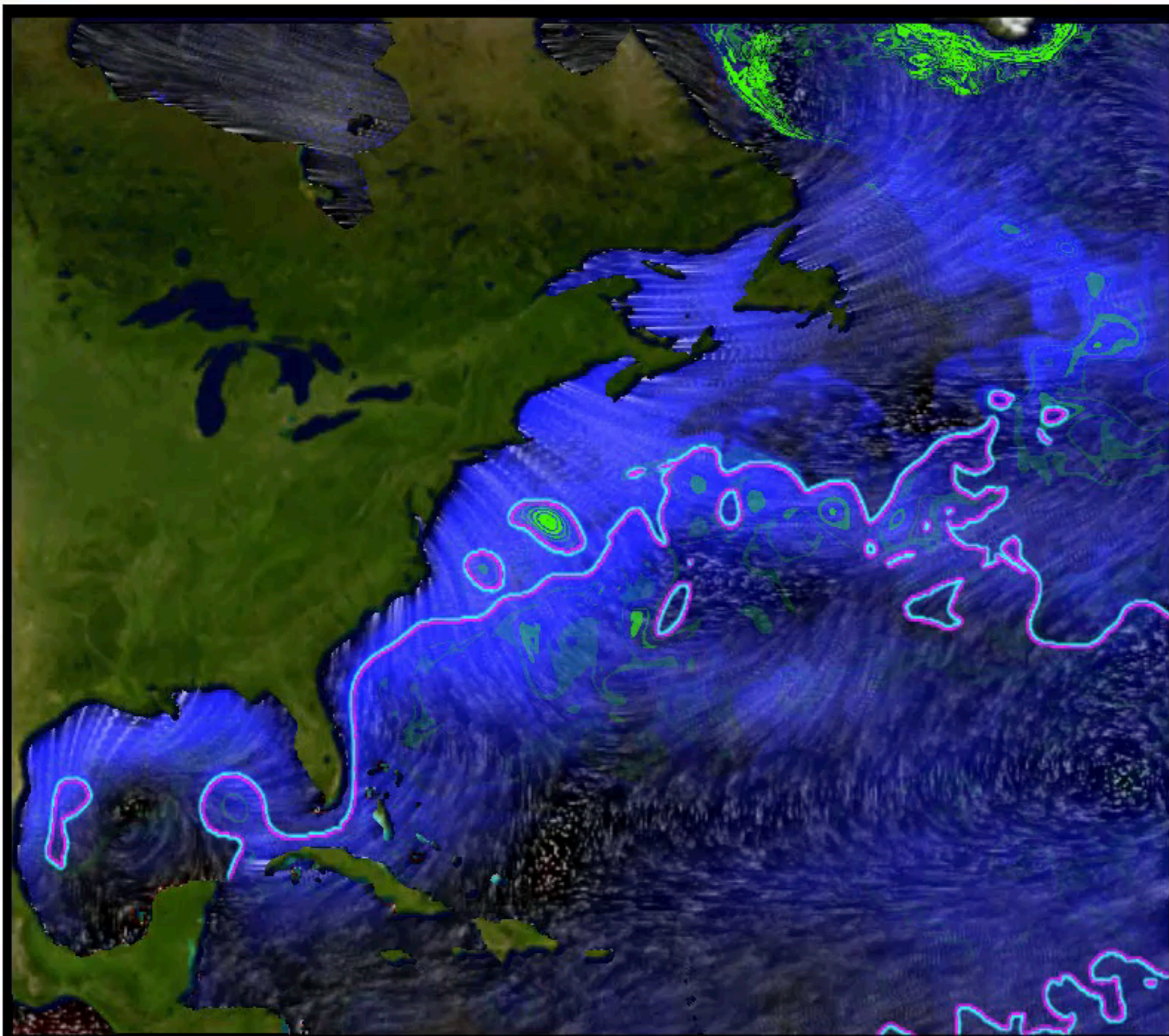
Defend the report during government approval



Weather,
Atmosphere
Fast

Ocean, Climate
Slow

3.4m of ocean
water has
same heat
capacity as
the WHOLE
atmosphere



ECCO Movie: Chris Henze, NASA Ames

tau / qflux / theta200m / kppMLD

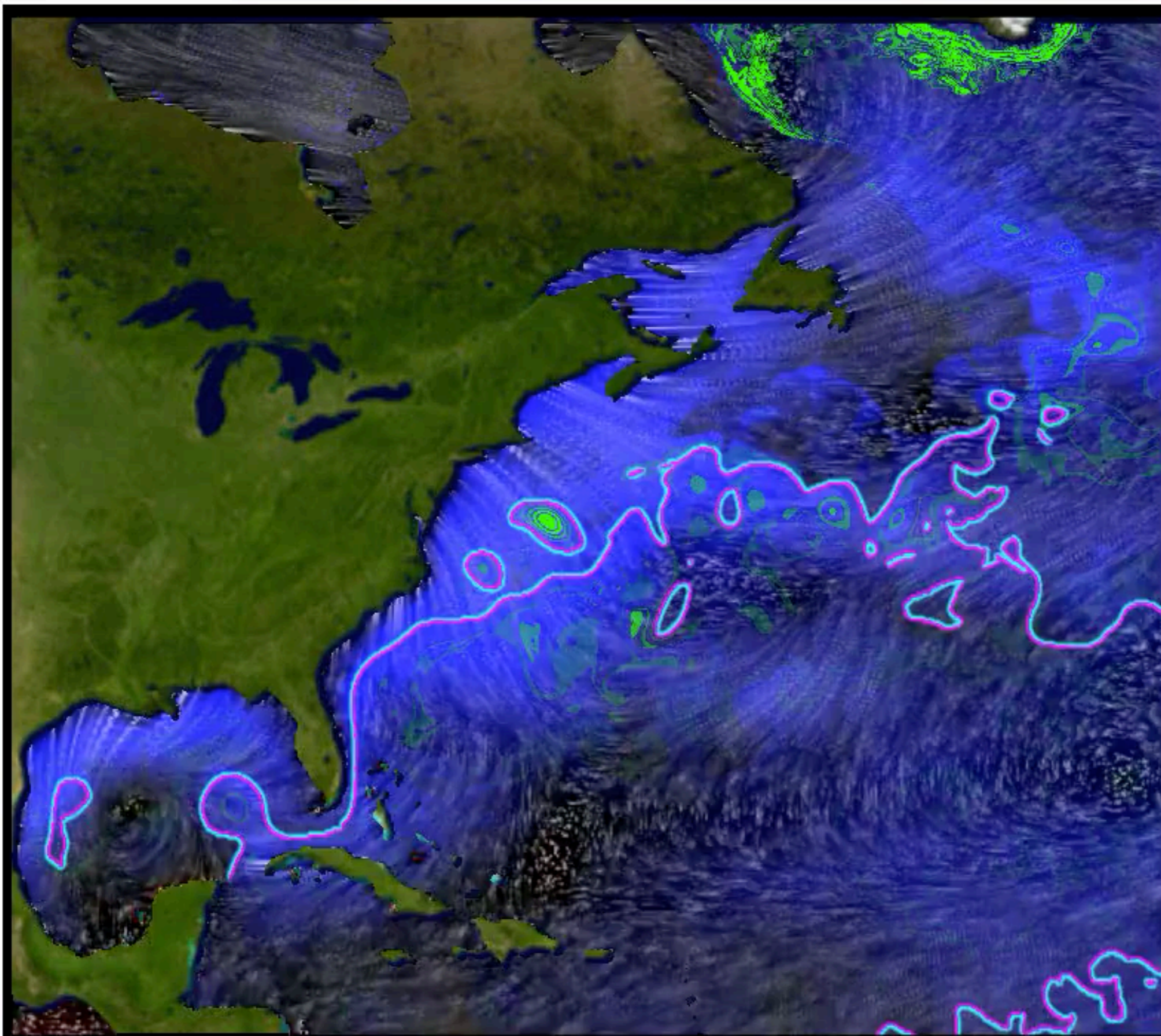
Jan 1 00:30 2001



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What do we know about climate?

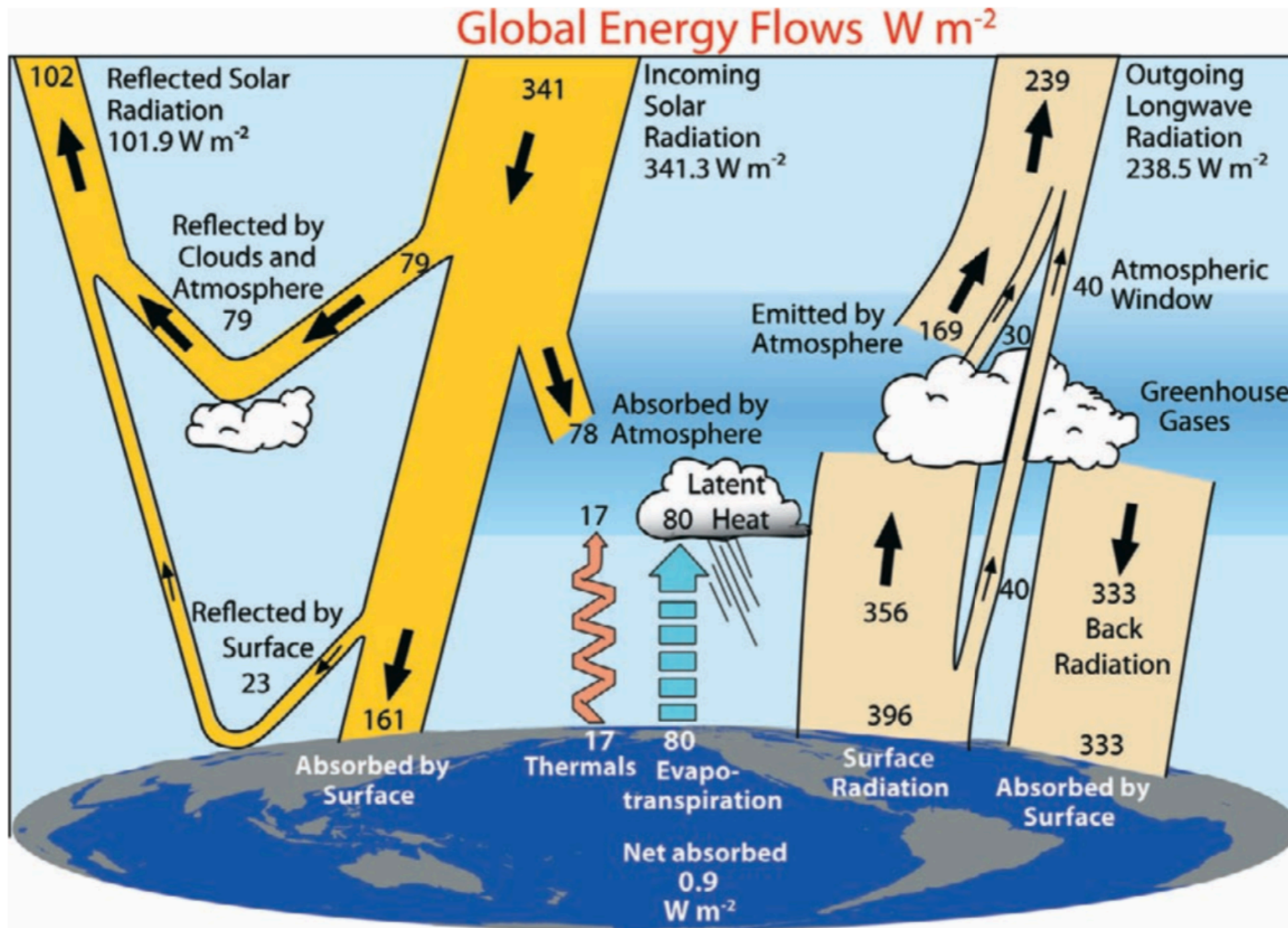


FIG. 1. The global annual mean Earth's energy budget for the Mar 2000 to May 2004 period ($W m^{-2}$). The broad arrows indicate the schematic flow of energy in proportion to their importance.

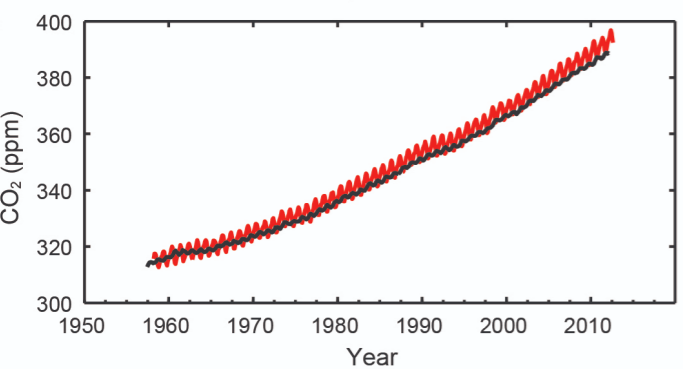
Trenberth et al., 2009

Observations:

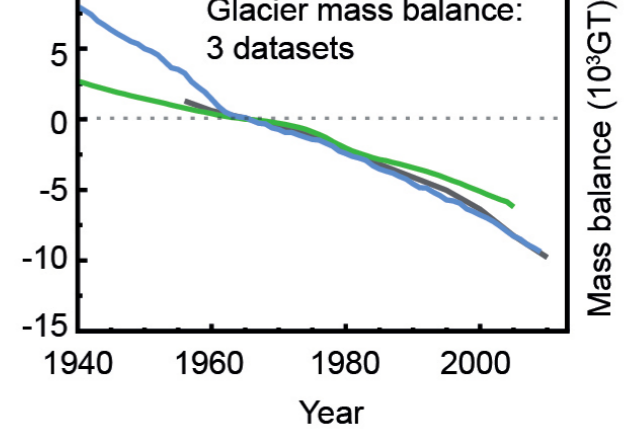
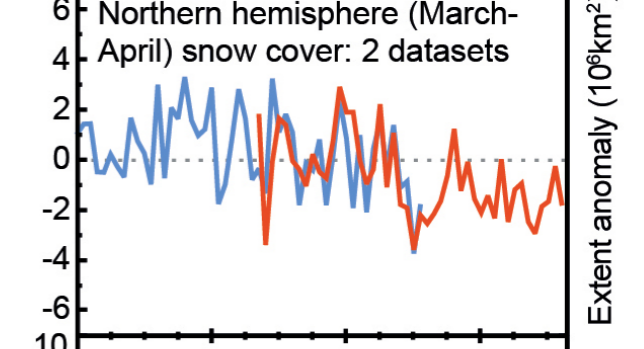
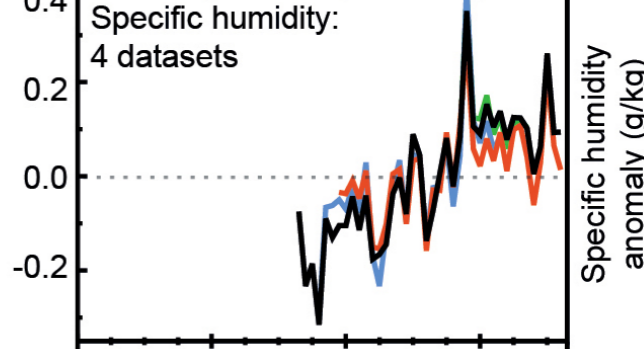
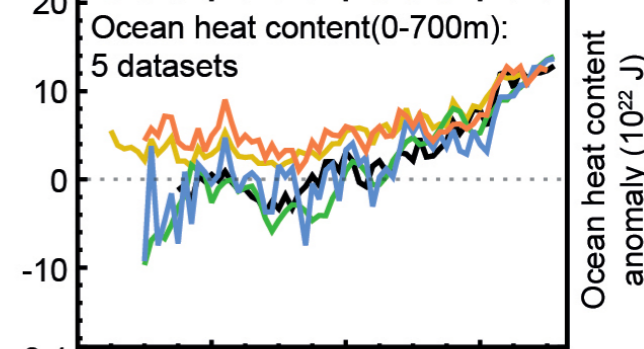
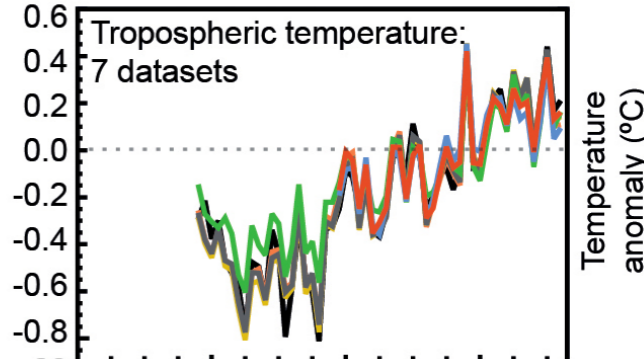
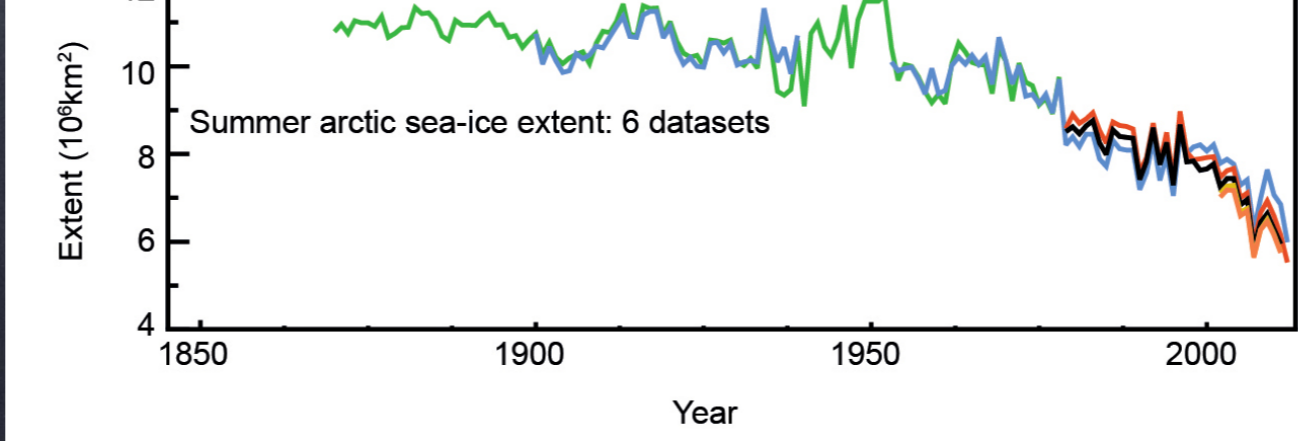
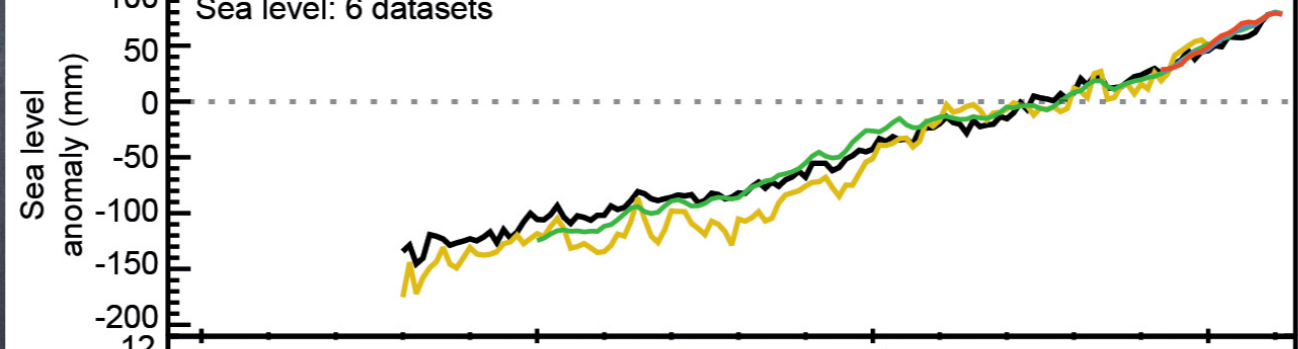
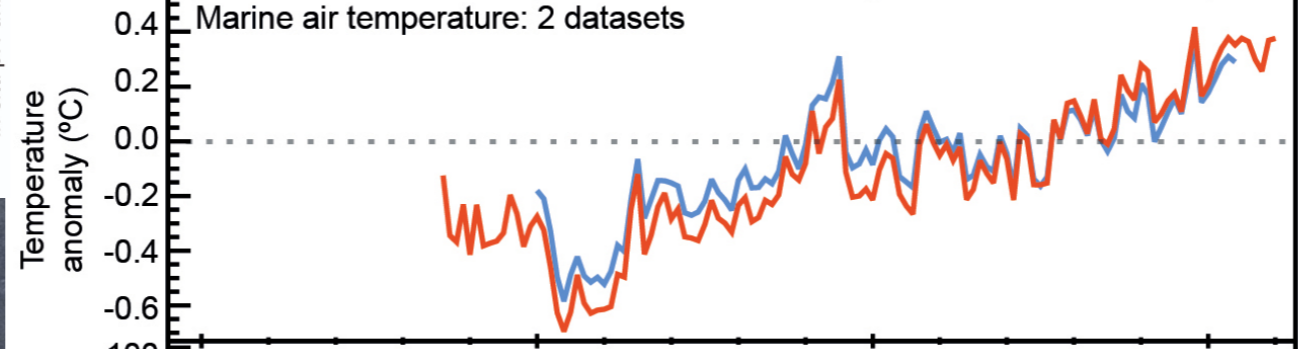
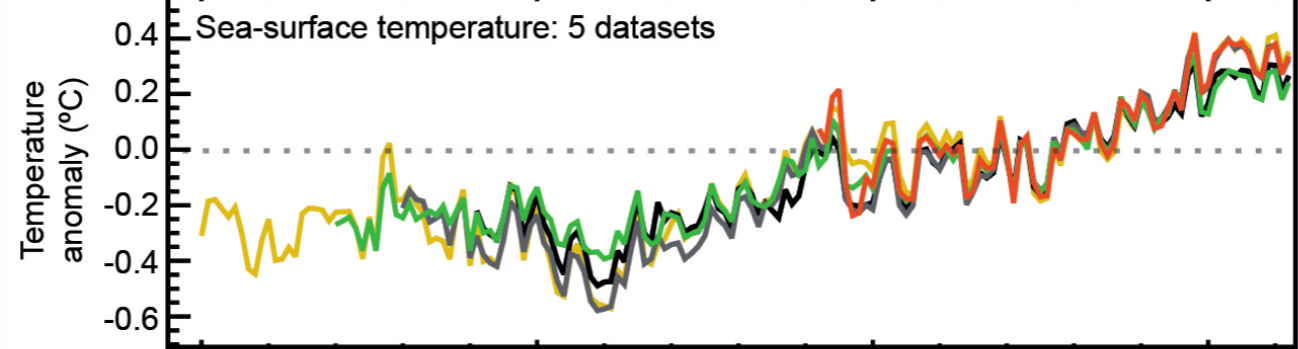
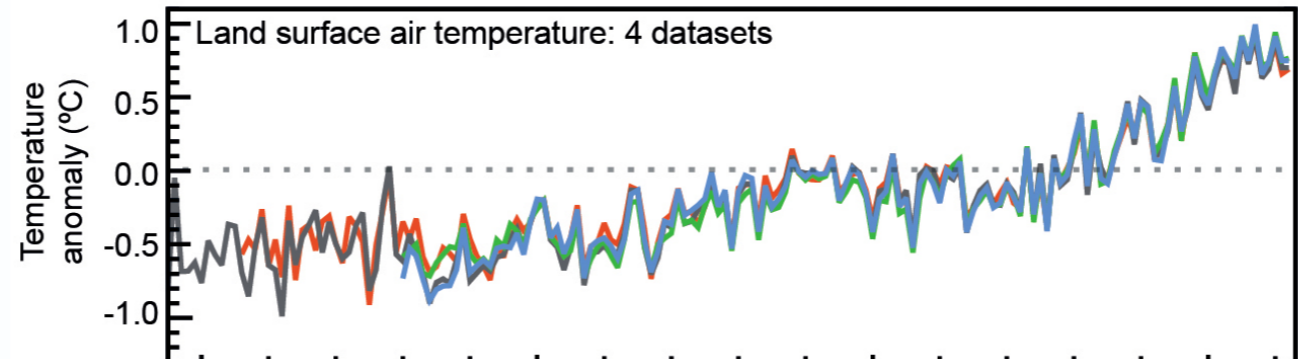
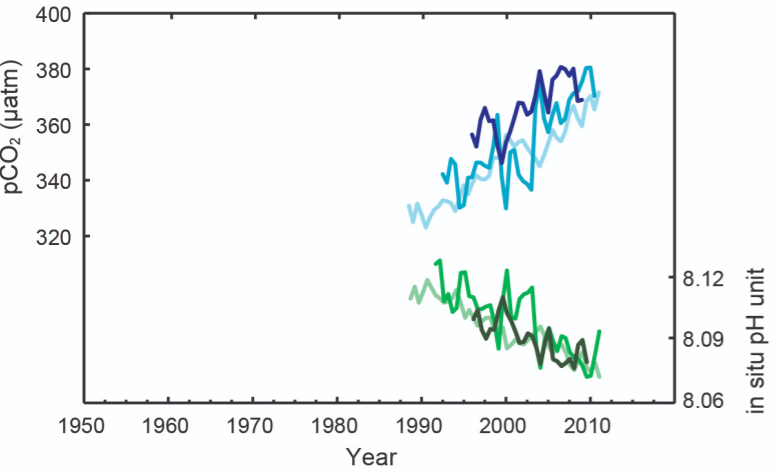
- First, what is changing?
- How does it relate to forcing?
- And what about sea level?

We'll begin with a few metrics from the IPCC Fifth Assessment Report (AR5, 2013)

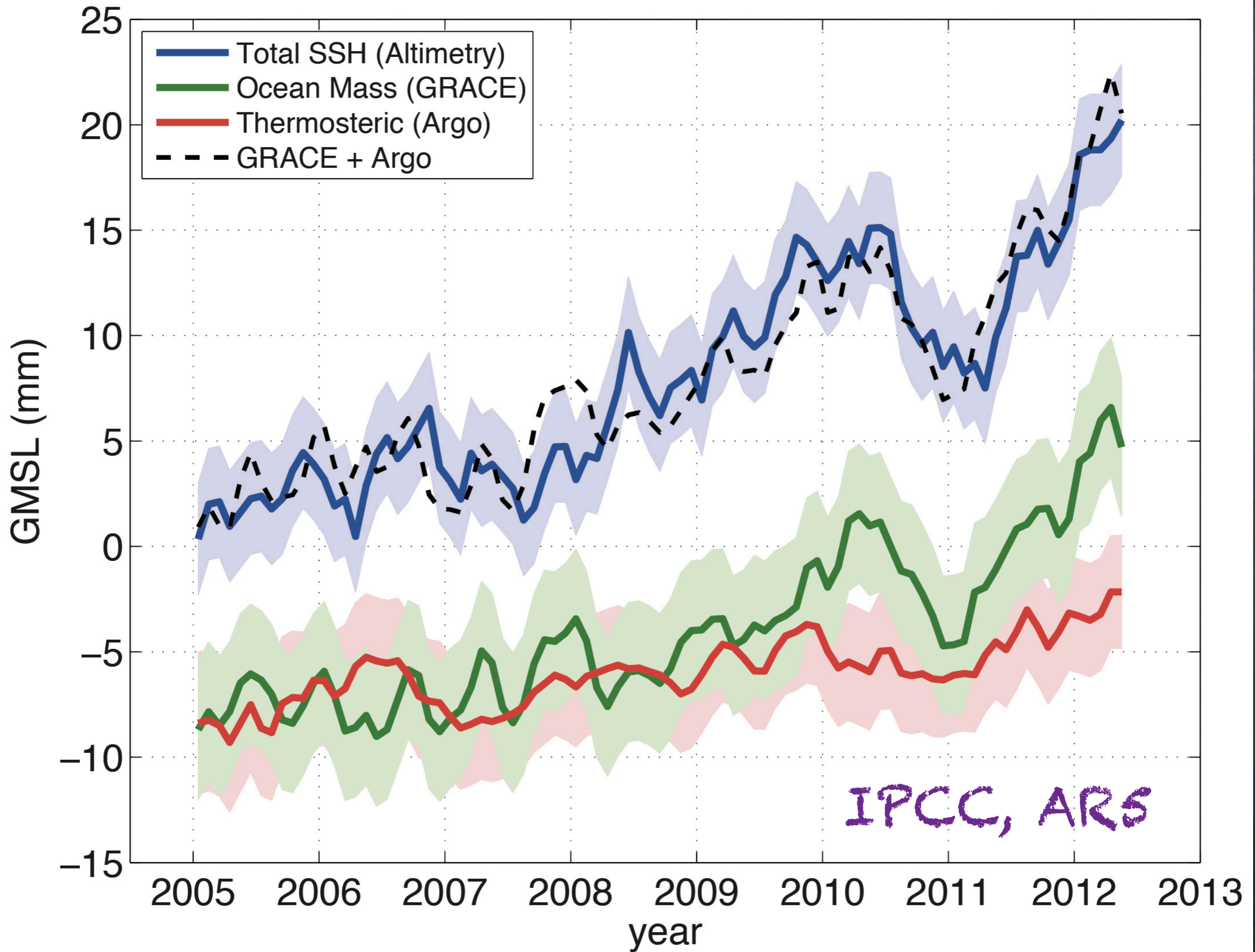
Atmospheric CO₂



Surface ocean CO₂ and pH



IPCC, AR5



Observed regional impacts from changes in the ocean and the cryosphere

		Ocean											
		Arctic	EBUS ¹	North Atlantic	North Pacific	South Atlantic	South Pacific	Southern Ocean	Temperate Indian Ocean	Tropical Atlantic	Tropical Indian Ocean	Tropical Pacific	
Greenhouse Gases	Physical changes	Temperature	●●	●	●●	●●	●●	●●	●●	●●	●●	●●	●
		Oxygen		●	●	●	●	●	●	●	●	●	●
		Ocean pH	●●●	●●●	●●●	●●●	●●●	●●●	●●●	●●●	●●●	●●●	●●●
		Sea-ice extent	●●●						●				
		Sea level	●	●●	●●	●●	●●	●●	●●	●●	●●	●●	●●
Climate Change	Ecosystems	Upper water column	●●	●	●●●	●●	●●	●●	●●	●	●●	●	●●
		Coral			●			●●●		●●●	●●●	●●●	
		Coastal wetlands			●●	●●	●●	●●		●●	●●	●●	
		Kelp forest	●●	●●	●●	●●	●	●		●		●	
		Rocky shores			●●●	●●				●			
		Deep sea				●							
		Polar benthos	●●						●●				
		Sea-ice-associated	●●						●●				
Human systems and ecosystem services	Fisheries	●●	●	●●●	●	●	●	●	●	●●	●	●	
	Tourism	●●	●		●		●	●	●			●	
	Habitat services	●●	●	●●	●●	●	●●		●●	●●	●●		
	Transportation/shipping	●●											
	Cultural services	●●		●	●		●						
	Coastal carbon sequestration			●●	●●	●	●		●	●	●●	●	

LEGEND

Physical changes

- increase
- decrease
- increase and decrease

Systems

- positive
- negative
- positive and negative

no assessment

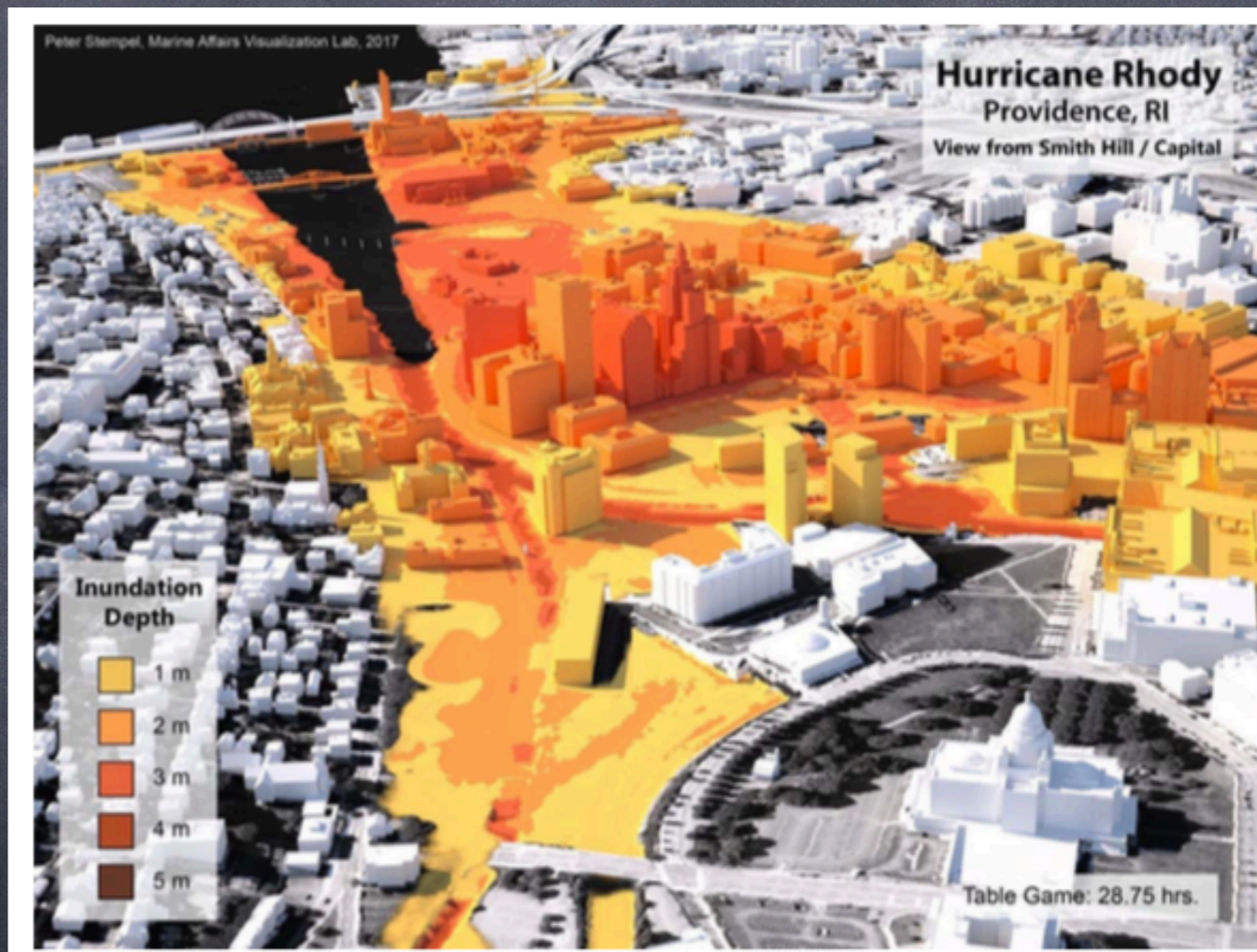
Attribution confidence

- high
- medium
- low

¹ Eastern Boundary Upwelling Systems (Benguela Current, Canary Current, California Current, and Humboldt Current); (Box 5.3)

RI Climate Challenges

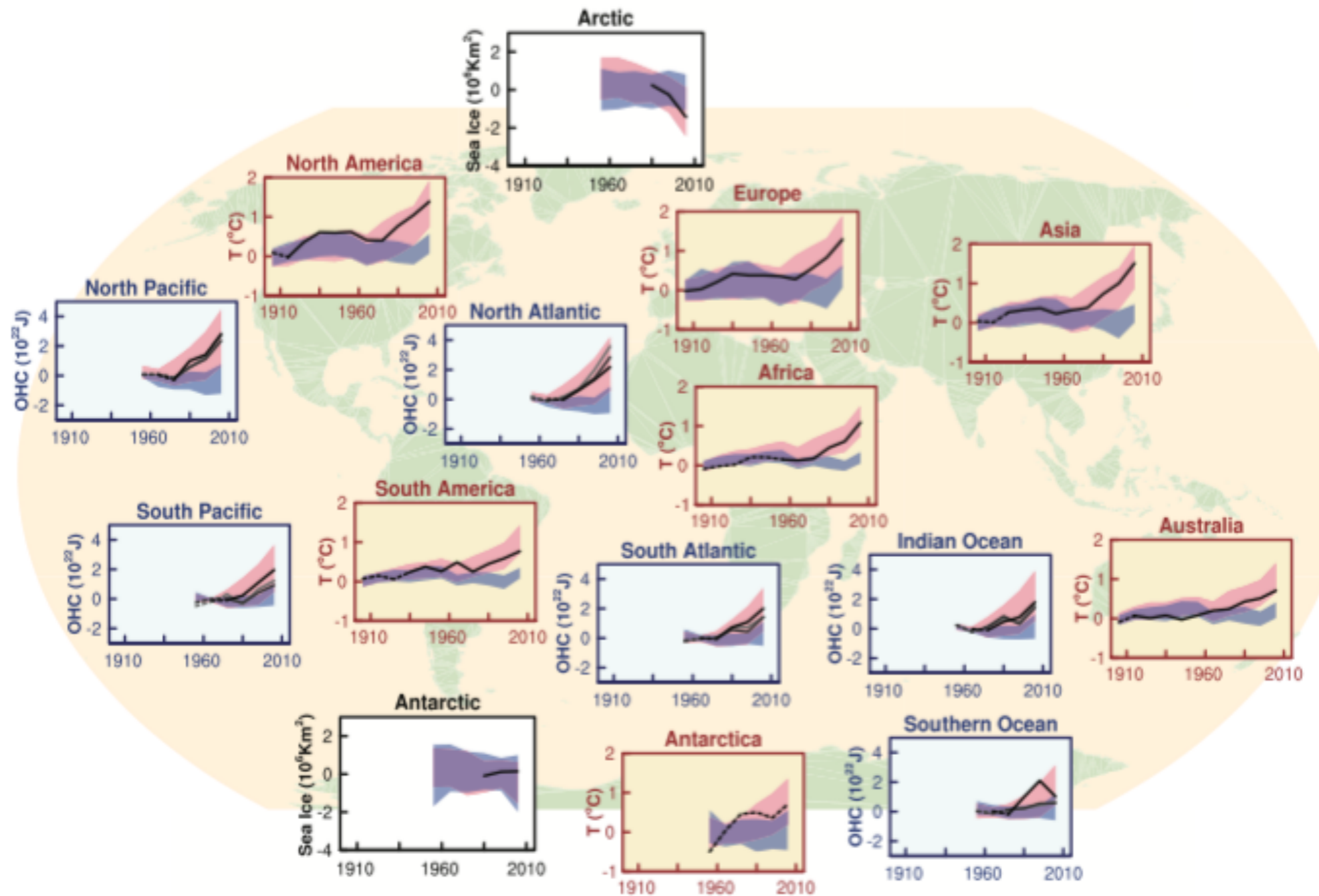
- ⦿ Flooding
- ⦿ Fish Kills/Hypoxia/Harmful Algal Blooms/Water Quality
- ⦿ Salt marsh degradation, historical coastal property at risk
- ⦿ Too warm for lobster, jonah & blue crabs moving in
- ⦿ Ocean acidification makes shellfish vulnerable
- ⦿ Hurricanes!
- ⦿ Earlier Spring, Later Fall
- ⦿ et cetera.



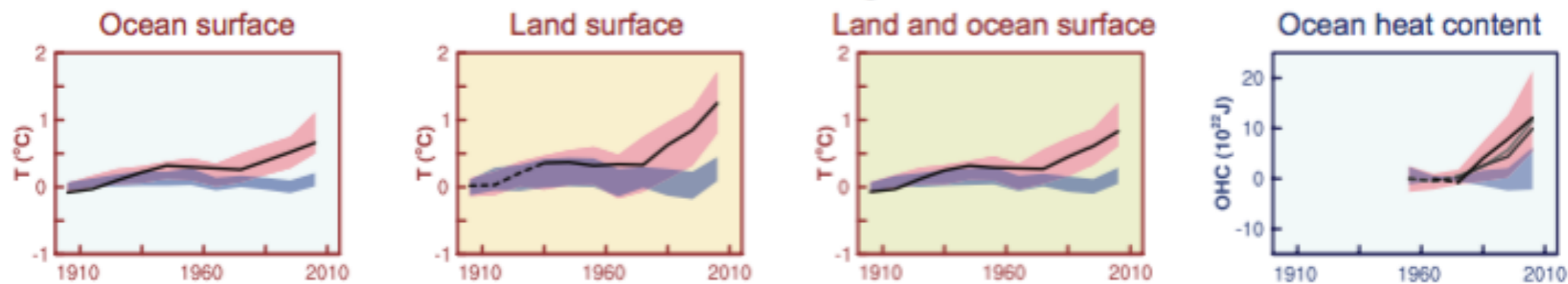
Stempel et al. (2018)

Detection and Attribution

A Temperature Change Story



Global averages



≡ Observations

■ Models using only natural forcings

■ Models using both natural and anthropogenic forcings

Models?

Trust Them?

- Causality through models
 - (There is no Planet B, also no control experiment)
- How good & consistent are they?
- What do future projections look like?
- What goes into models?
- Why can't we just get a bigger computer?

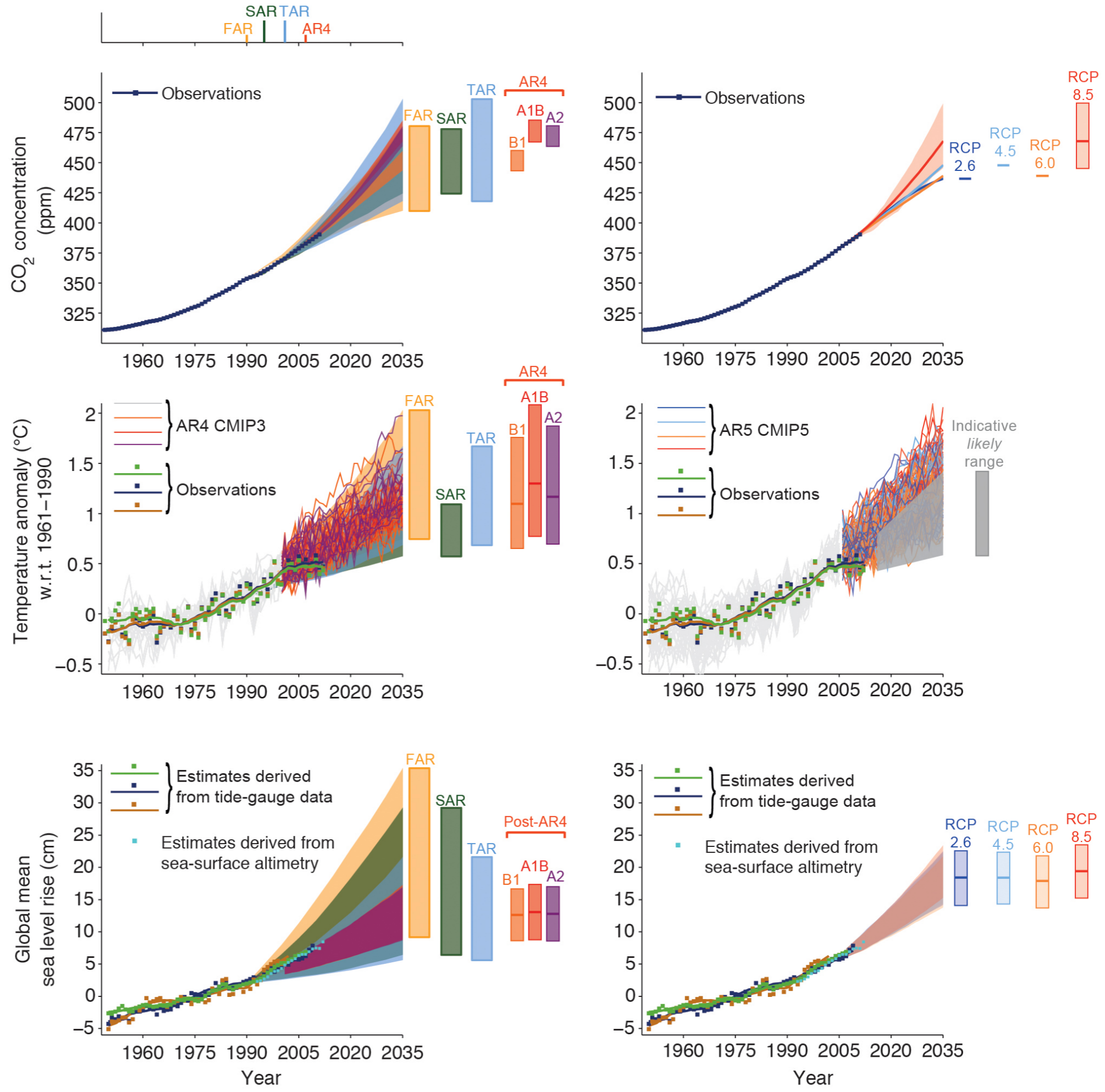


Video: ZEKE HAUSFATHER, Carbon Brief, 2017

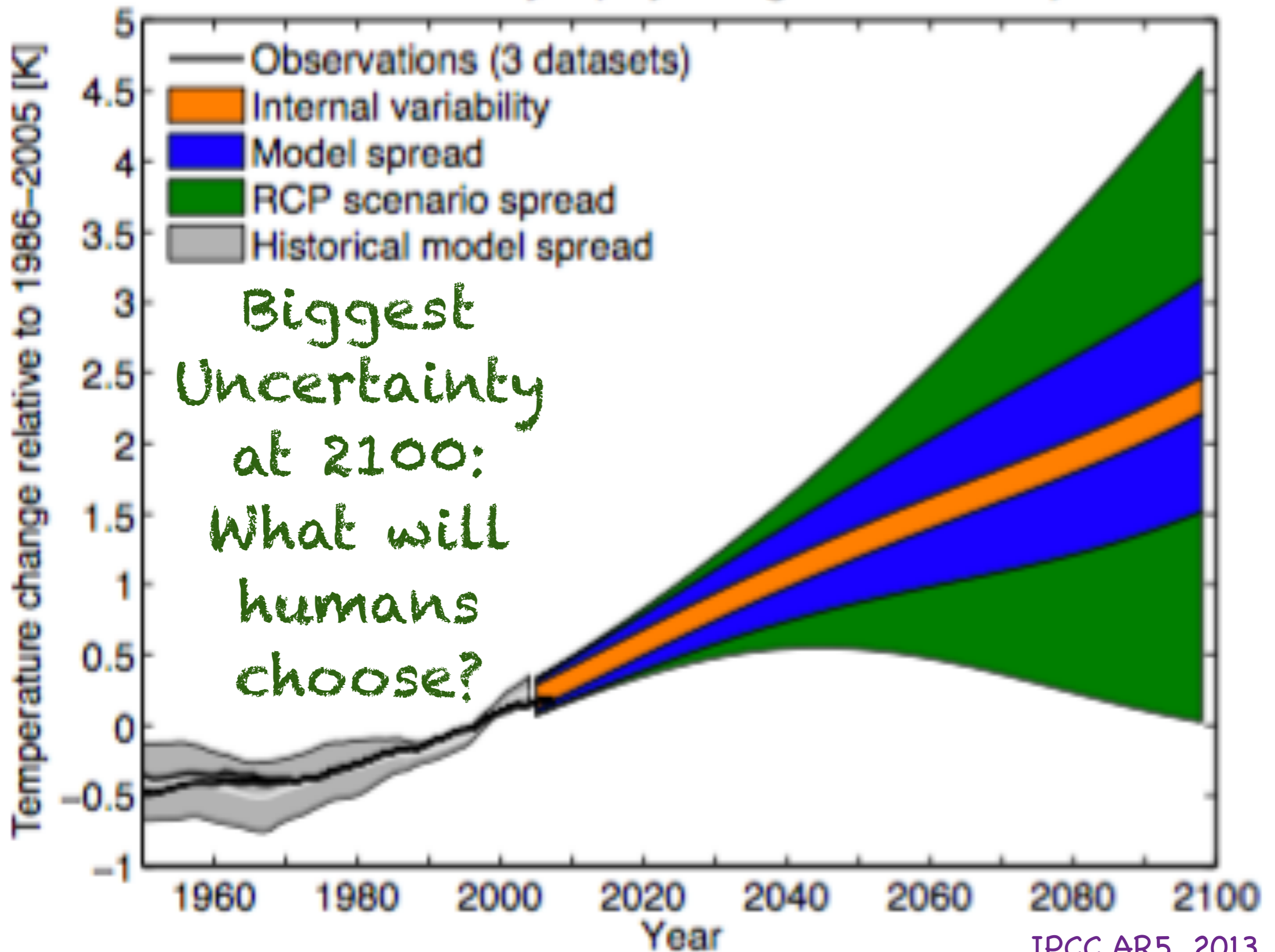
www.carbonbrief.org/analysis-how-well-have-climate-models-projected-global-warming

Models & Understanding

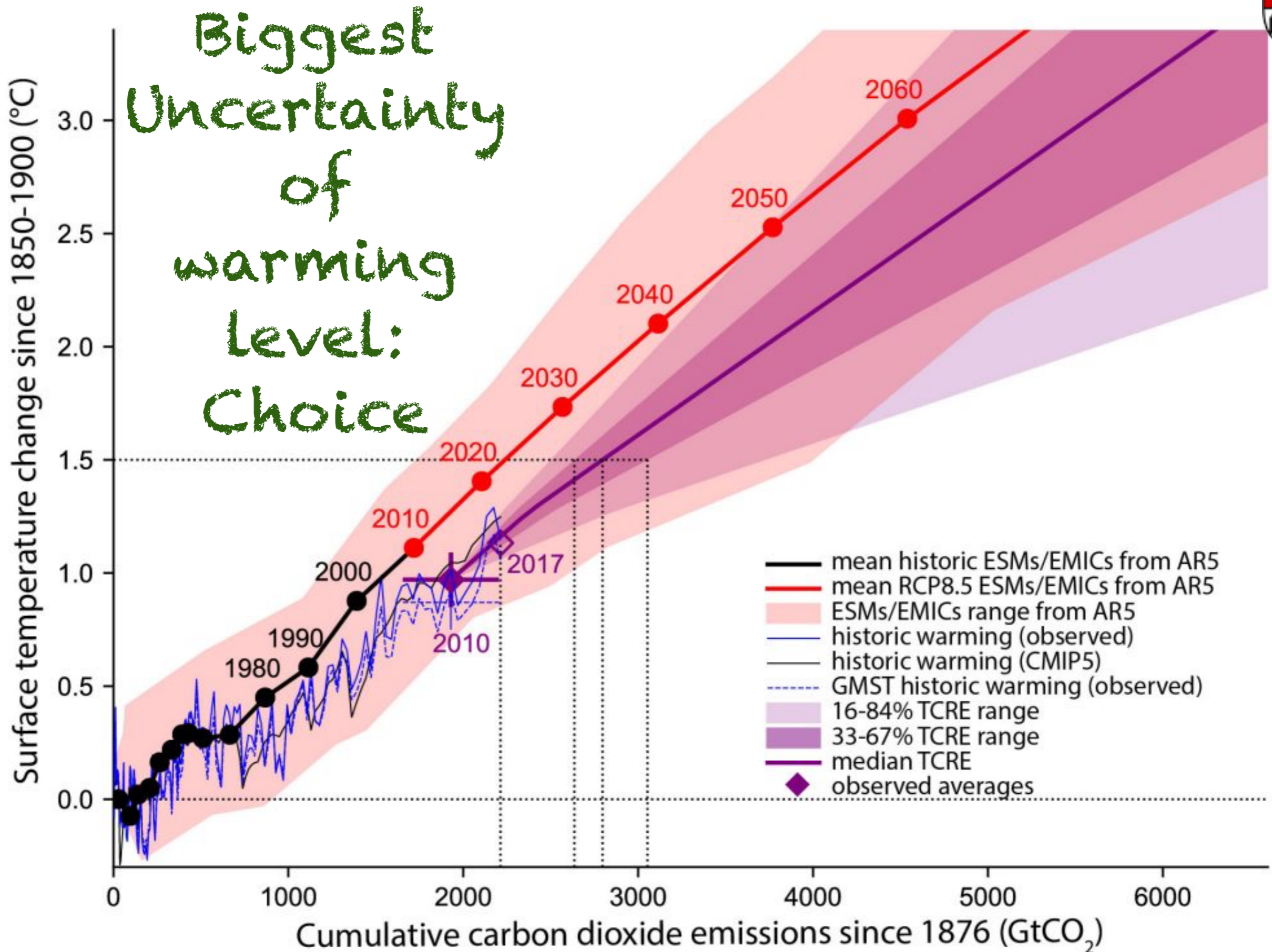
The comparison between the four previous reports highlights the evolution in our understanding of how the climate system responds to changes in both natural and anthropogenic forcing and provides an assessment of how the projections compare with observational estimates.



Sources of uncertainty in projected global mean temperature



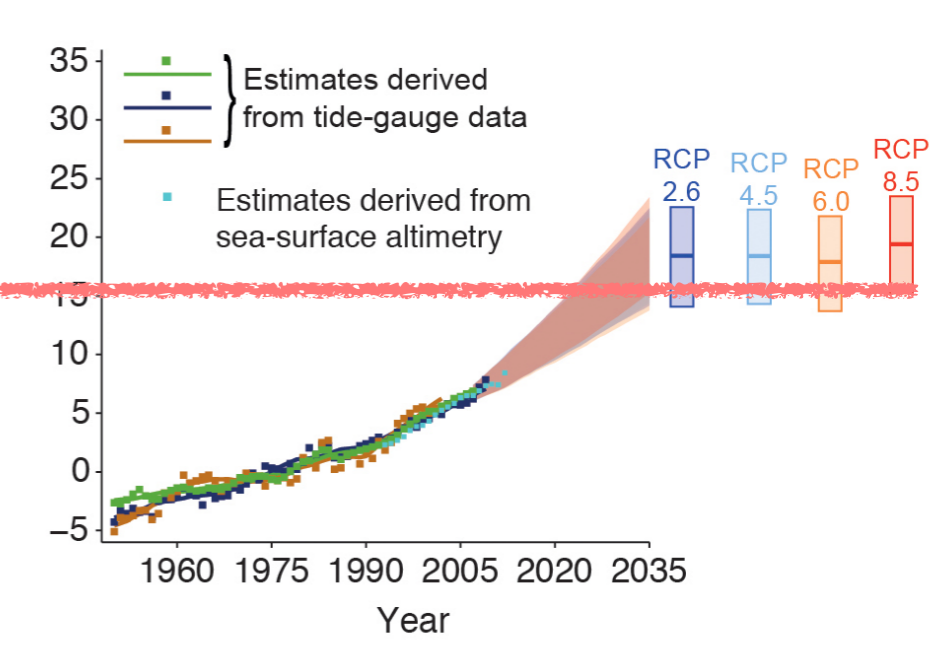
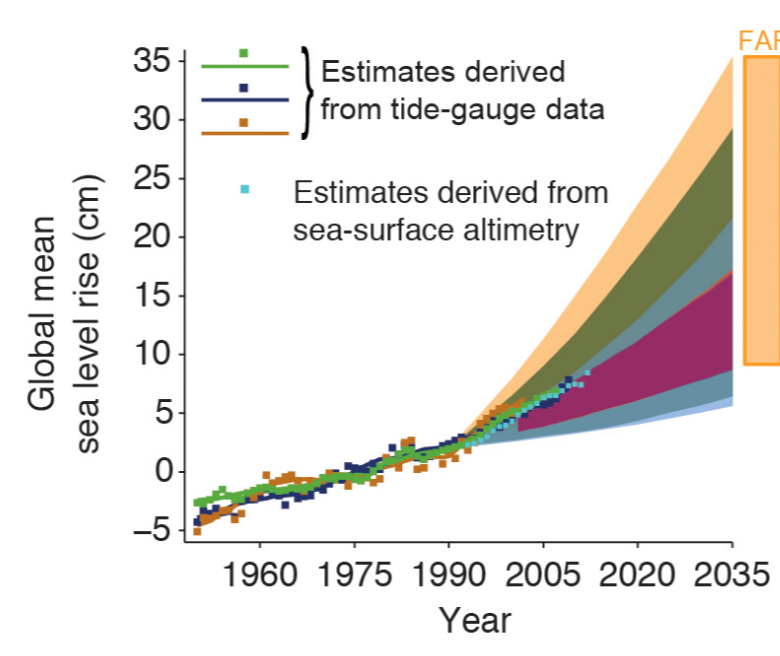
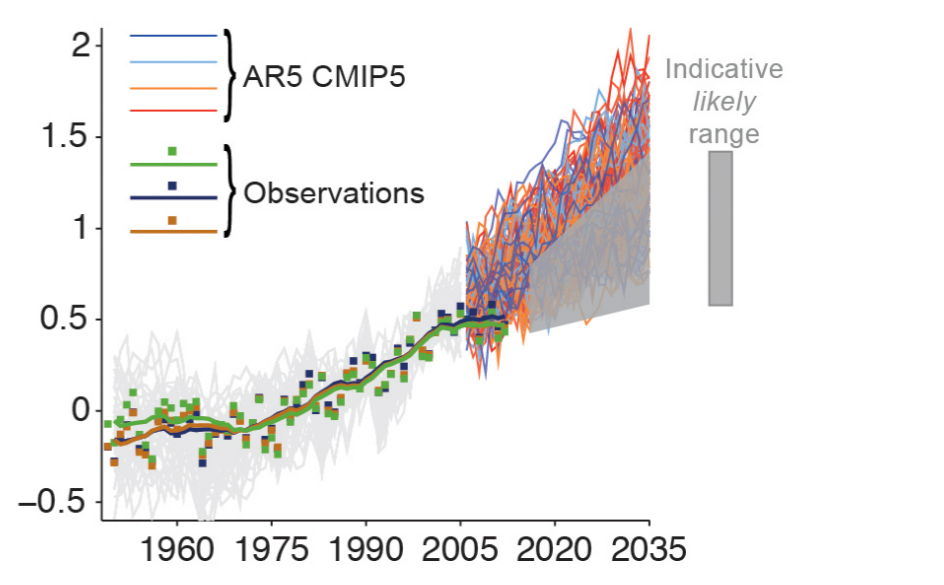
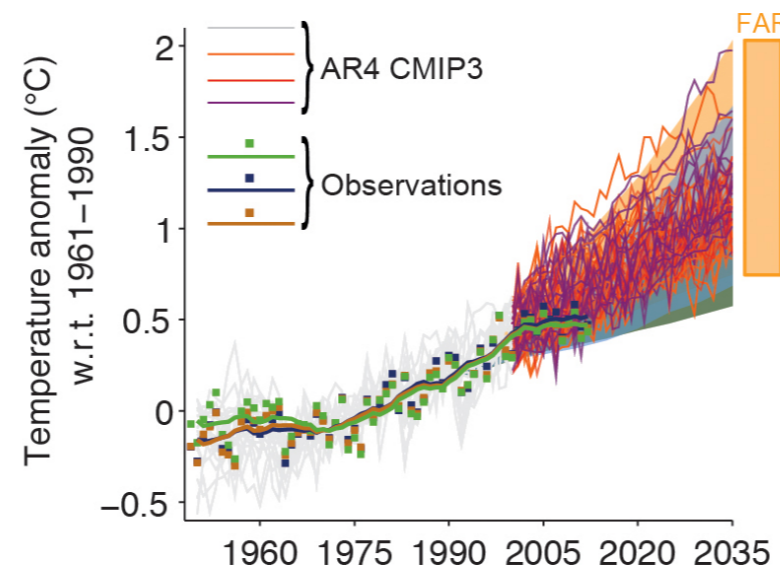
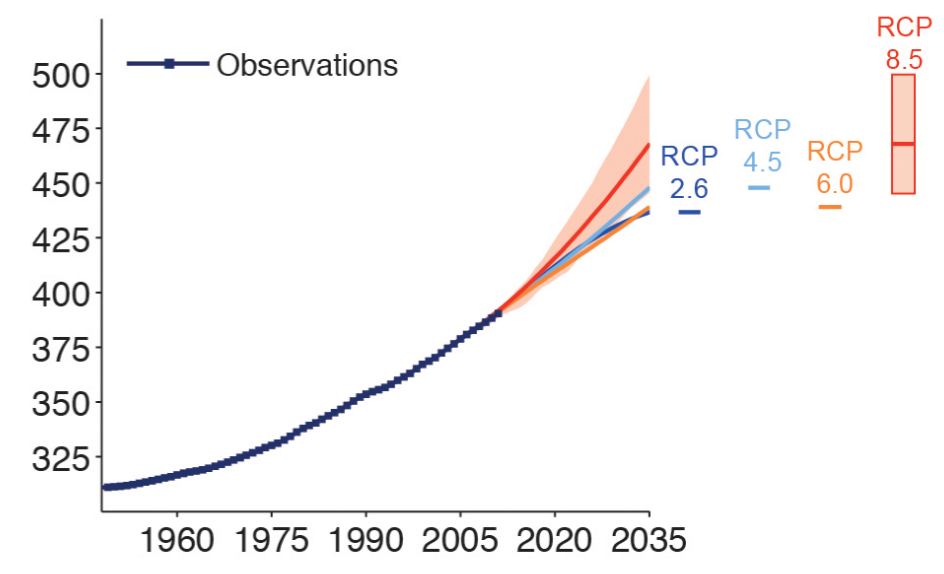
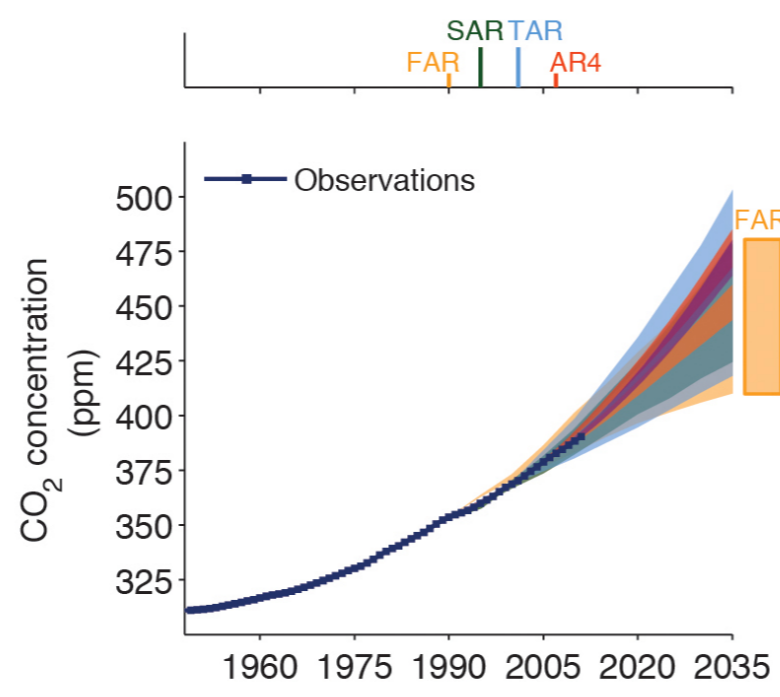
What sets the magnitude?



Note:
 Sea Level Rise
 at 2035 is
 essentially
 independent
 of scenario

That is, it's
 already been
 "cooked in"
 by past warming
 and emissions

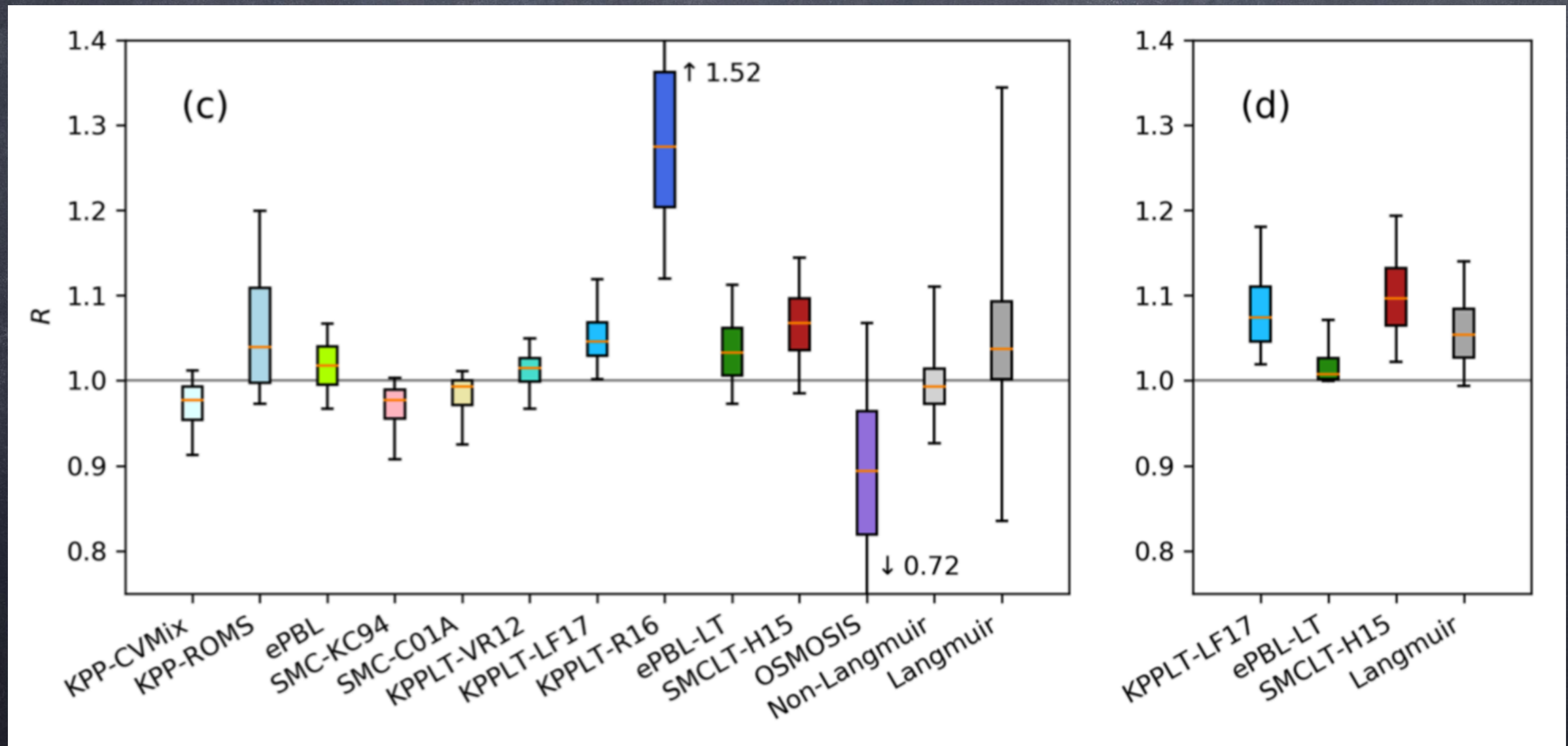
We have to look
 farther ahead to
 find when our
 emissions make
 a difference
 in sea level



Models and Processes



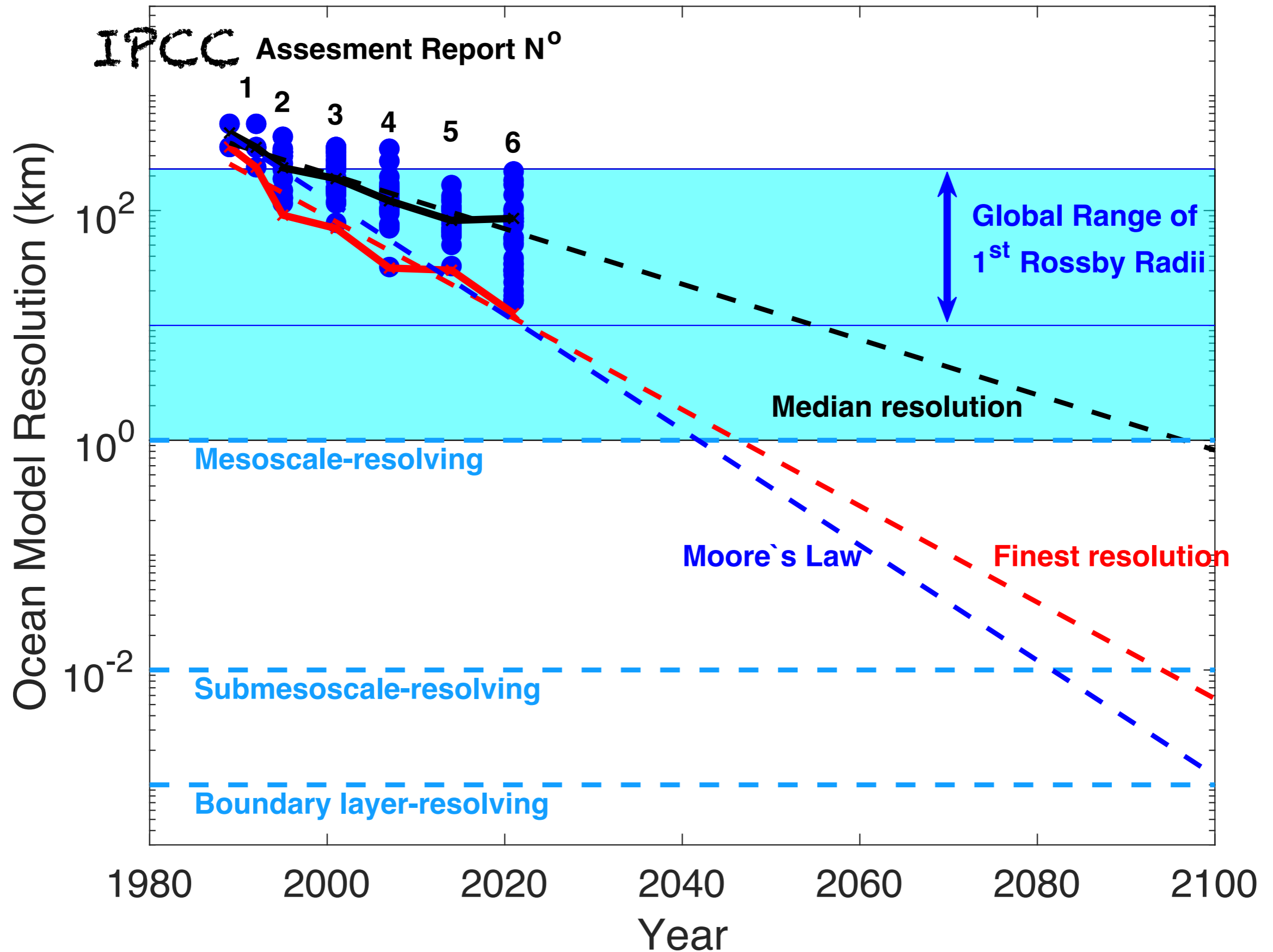
To the extent possible, we build climate models from first principle understanding of the earth system, not from statistical modeling of past observations. Like the stock market—past performance is not indicative of future results because the climate is changing.



Grasping at straws?

Li et al., 2019

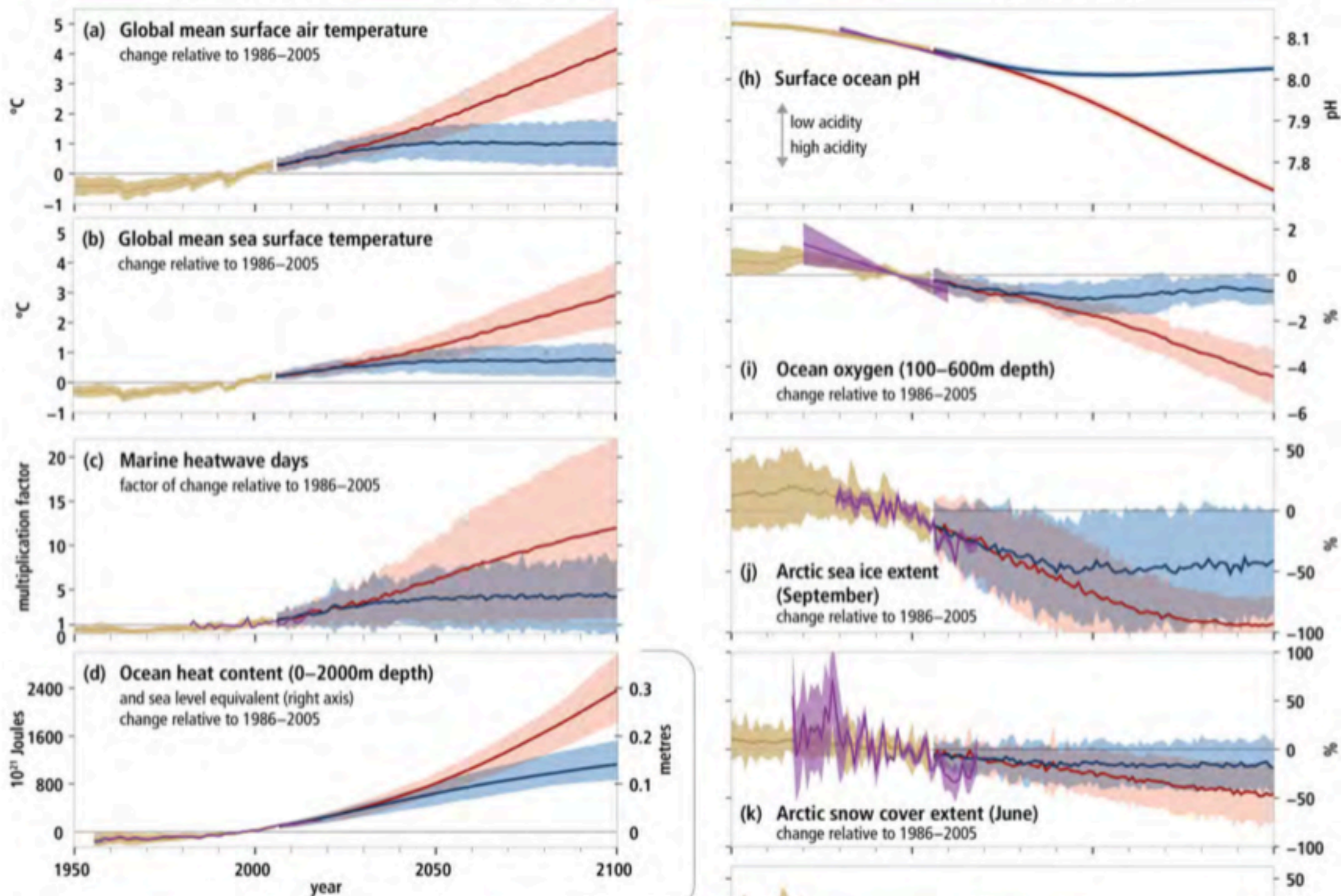
Use a bigger computer?



Past and future changes in the ocean and cryosphere

Historical changes (observed and modelled) and projections under RCP2.6 and RCP8.5 for key indicators

■ Historical (observed)
 ■ Historical (modelled)
 ■ Projected (RCP2.6)
 ■ Projected (RCP8.5)



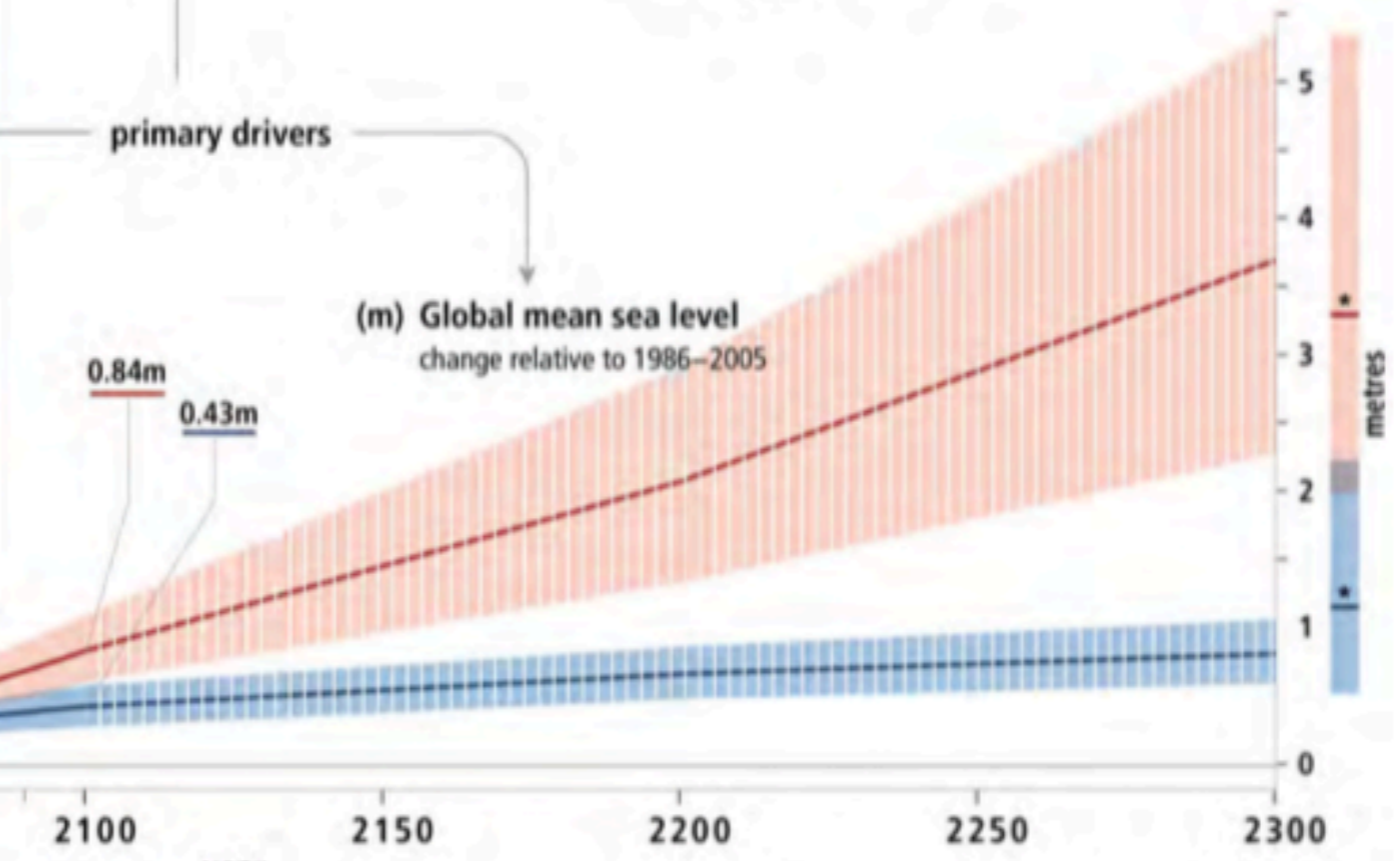
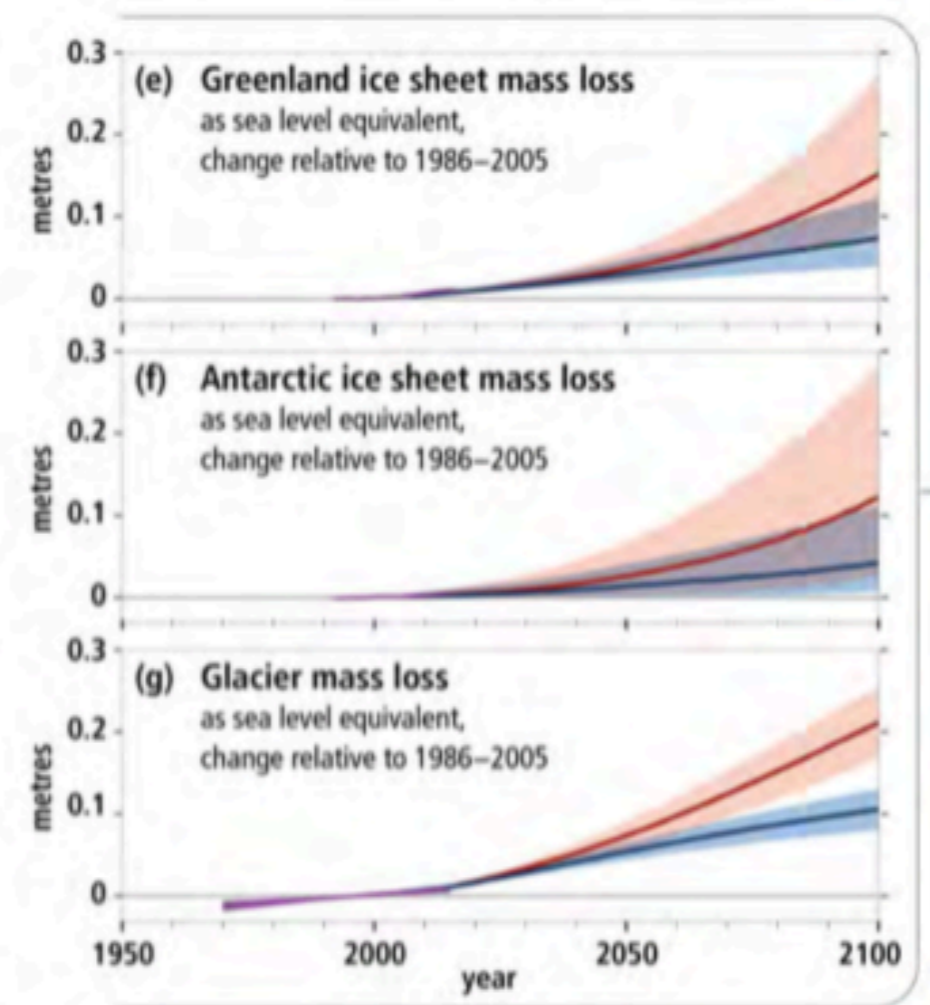
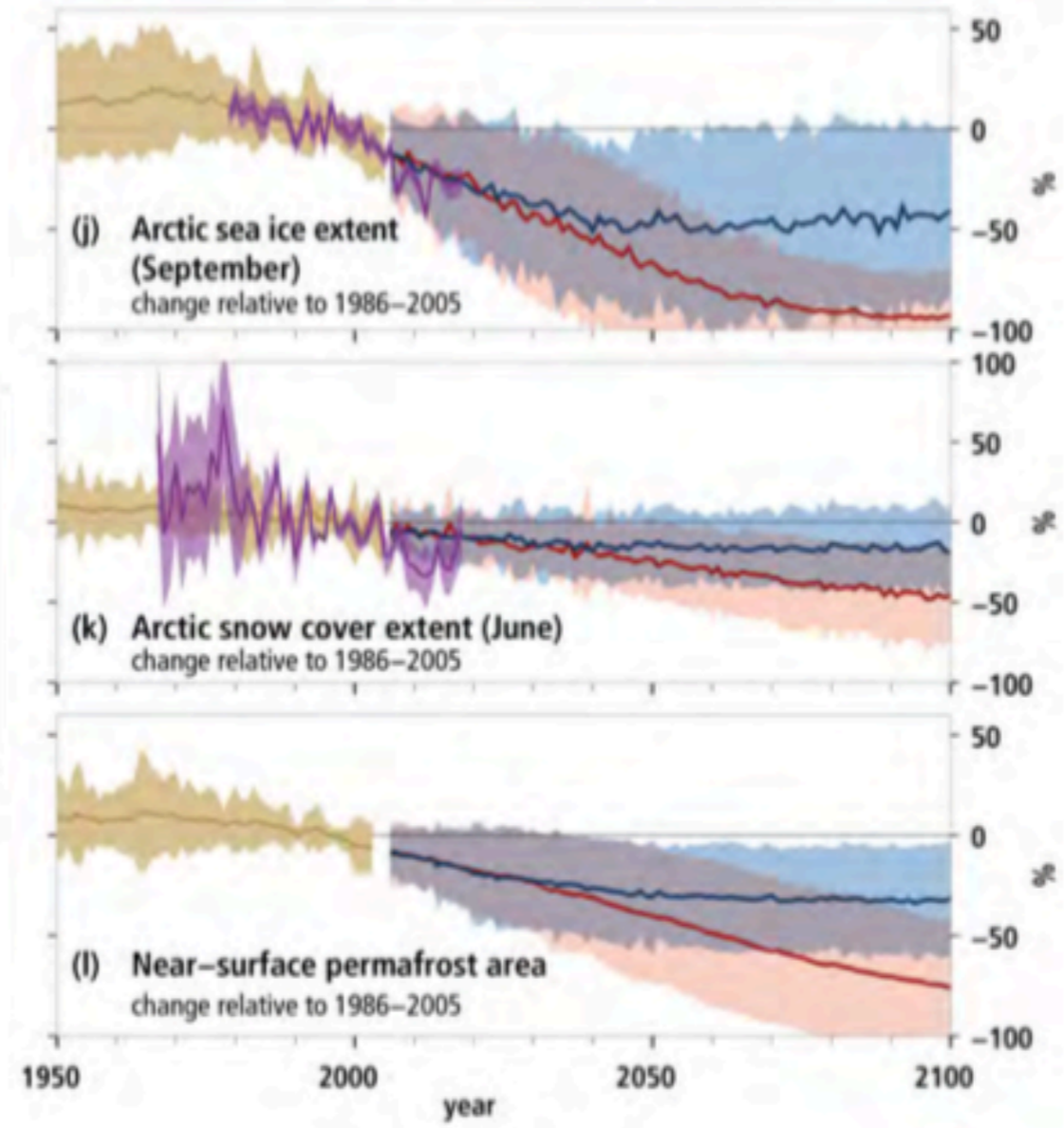
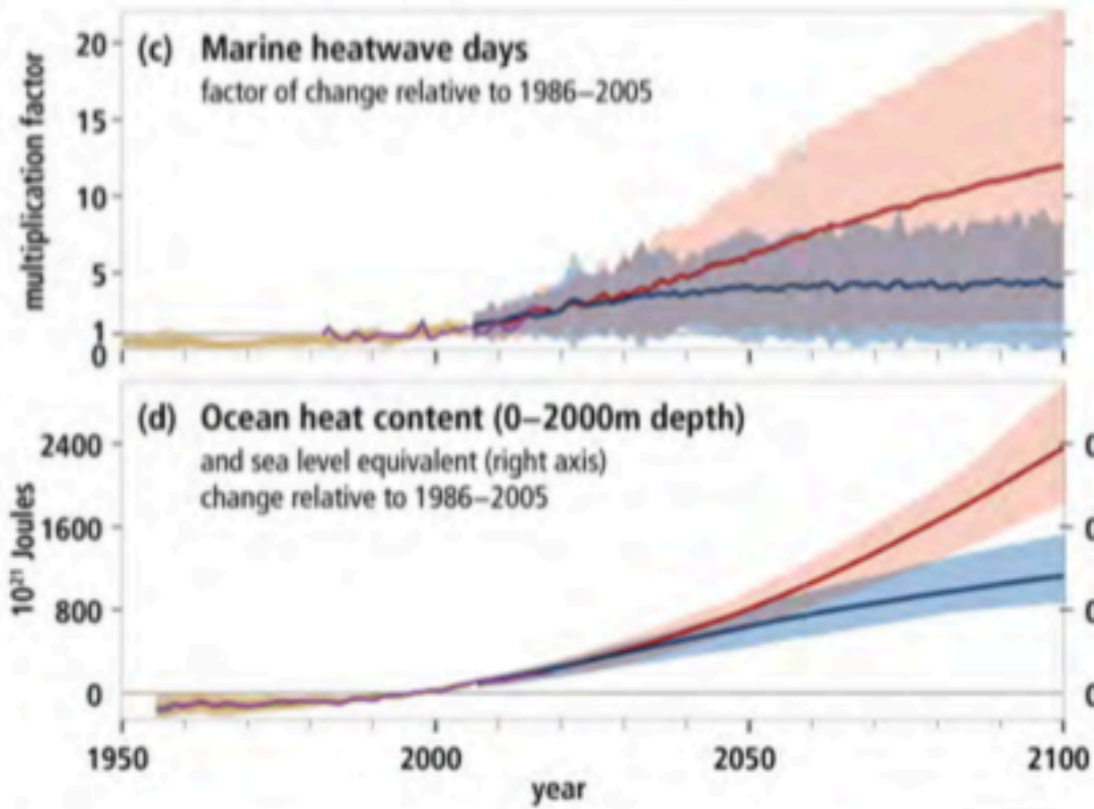


Table SPM.1: Projected global mean surface temperature change relative to 1850–1900 for two time periods under four RCPs¹⁶.

Scenario	Near-term: 2031–2050		End-of-century: 2081–2100	
	Mean (°C)	<i>likely</i> range (°C)	Mean (°C)	<i>likely</i> range (°C)
RCP2.6	1.6	1.1 to 2.0	1.6	0.9 to 2.4
RCP4.5	1.7	1.3 to 2.2	2.5	1.7 to 3.3
RCP6.0	1.6	1.2 to 2.0	2.9	2.0 to 3.8
RCP8.5	2.0	1.5 to 2.4	4.3	3.2 to 5.4

{Cross-Chapter Box 1 in Chapter 1}

	RCP2.6	RCP4.5	RCP8.5	Comments
GMSL 2031–2050	0.17(0.12–0.22)	0.18(0.13–0.23)	0.20(0.15–0.26)	SROCC
GMSL 2046–2065	0.24 (0.17–0.32)	0.26 (0.19–0.34)	0.32 (0.23–0.40)	SROCC
GMSL 2081–2100	0.39 (0.26–0.53)	0.49 (0.34–0.64)	0.71 (0.51–0.92)	SROCC
GMSL in 2100	0.43 (0.29–0.59)	0.55 (0.39–0.72)	0.84 (0.61–1.10)	SROCC
Rate (mm yr⁻¹)	4(2–6)	7(4–9)	15(10–20)	SROCC

GMSL (m), relative to 1985–2006



Is it the magnitude or the rate of warming that counts?

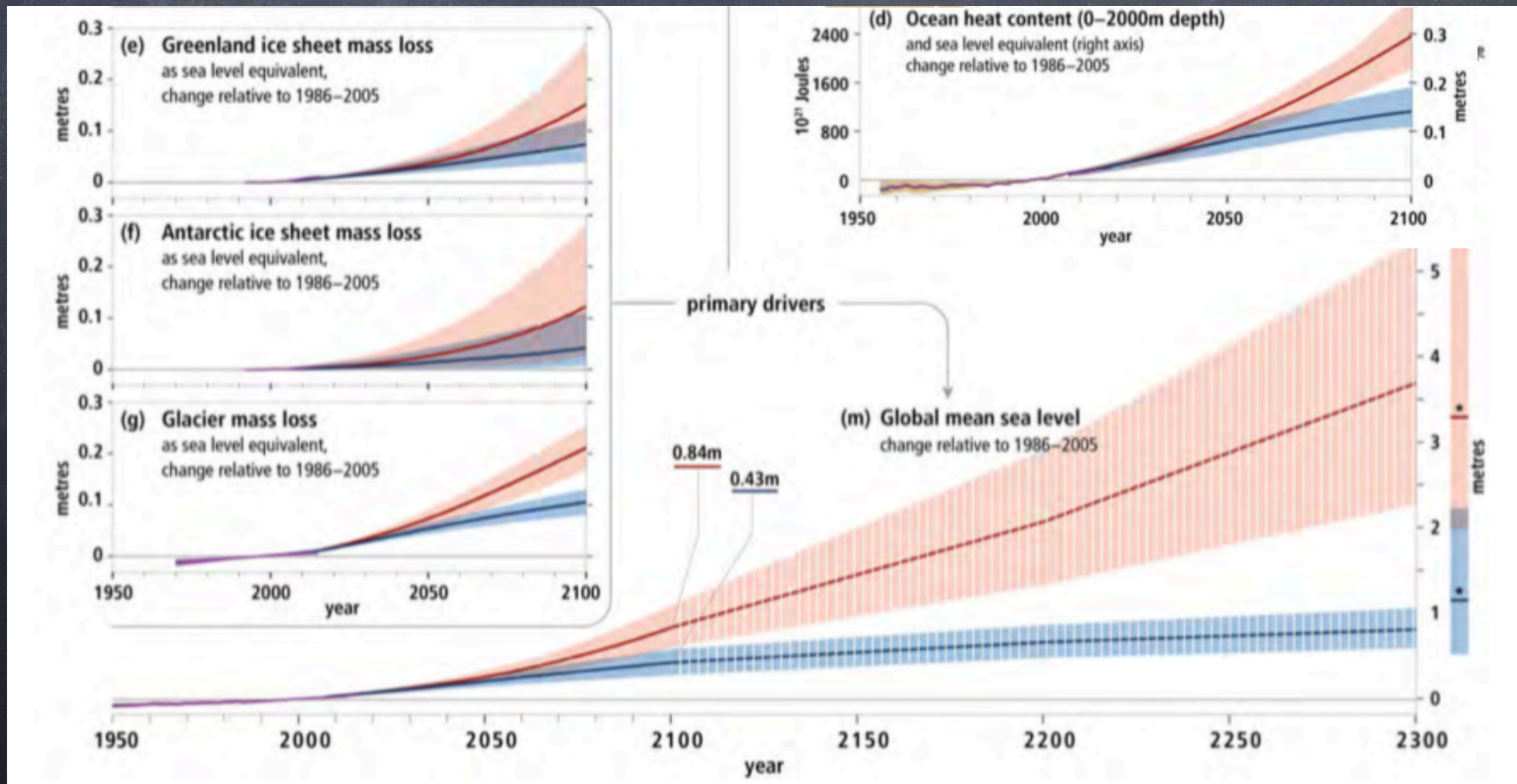
- Heat Waves? Magnitude
- Tipping Points? Magnitude
- Sea Level Rise? Magnitude
- Species Extinctions? Rate
- Economy? Both Magnitude & Rate
- Developing World? Both Magnitude & Rate

What sets the rate?



Not Only Us: Sea Level until 2300

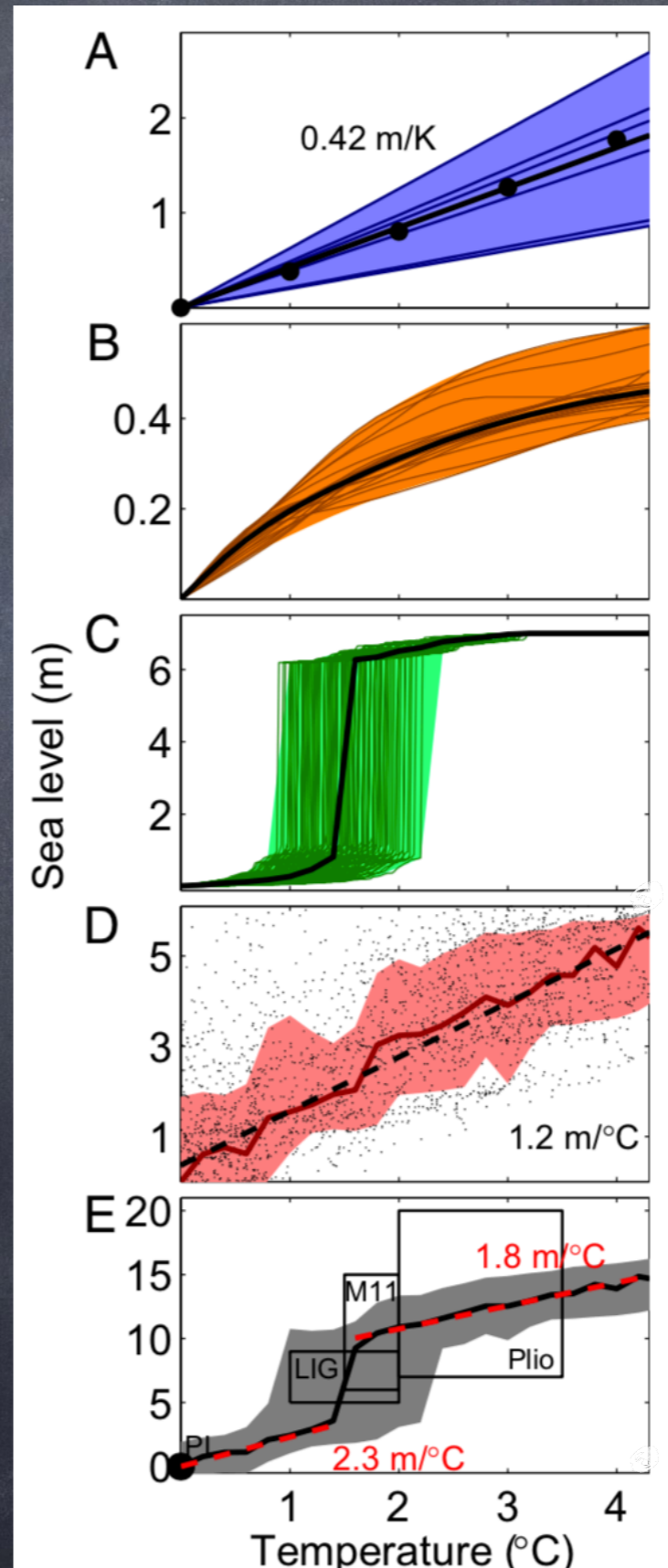
Even when emissions are ceased near 2100, the sea level continues to rise for hundreds of years as the slower ocean & ice sheet responses accumulate.





I fear commitment

- (A) ocean warming,
- (B) mountain glaciers and ice caps
- (C) Greenland Ice Sheet
- (D) Antarctic Ice Sheets
- (E) The total sea-level commitment



Multi-millennial commitment

Levermann et al. 2013

paleo-warm periods (PI, preindustrial, Plio, mid-Pliocene, LIG, last interglacial).

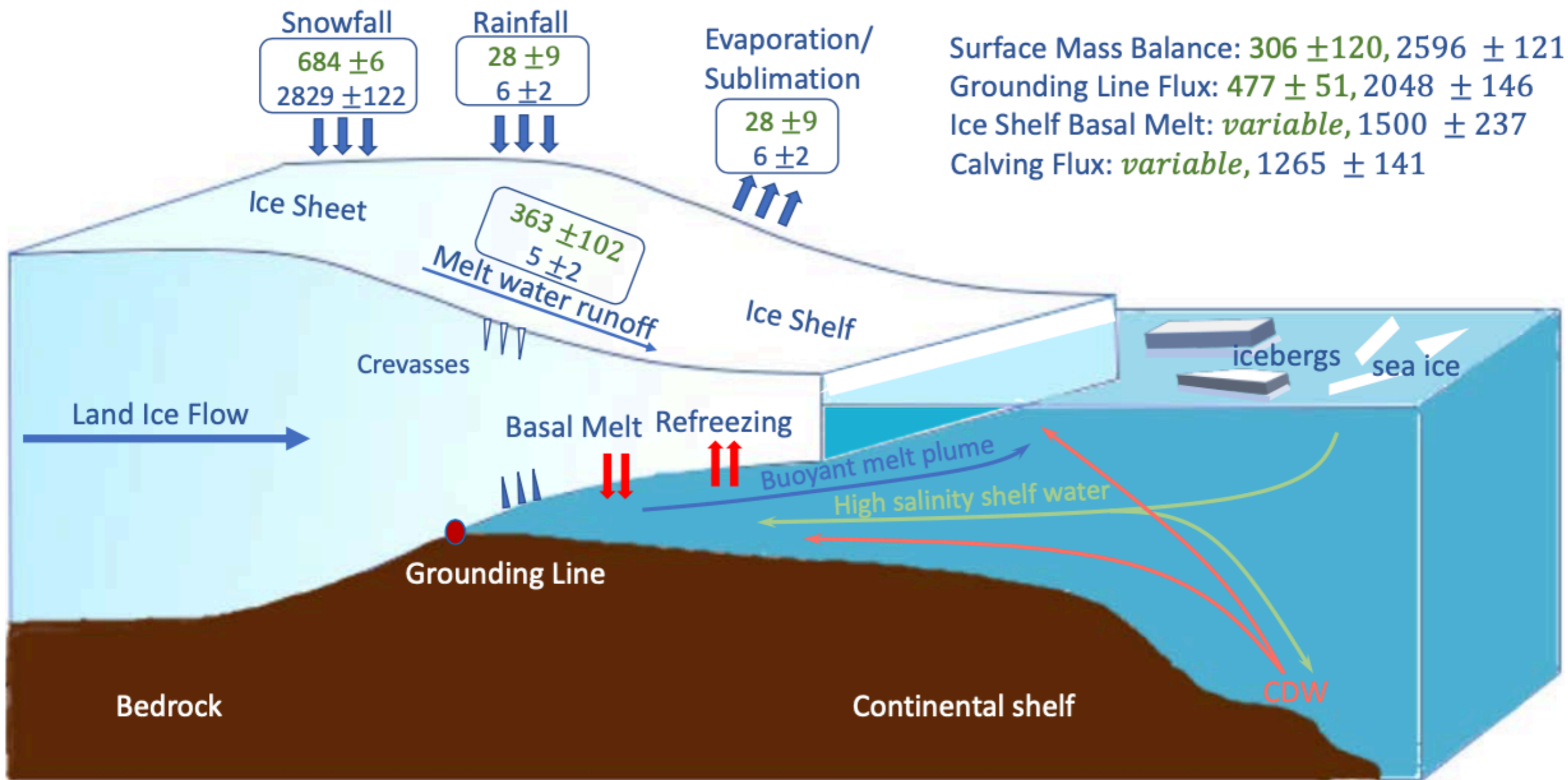


FIGURE 1. Schematic representation of ice sheet mass exchange with the atmosphere and ocean. Typical mass fluxes for the Antarctic (blue) and Greenland (green) Ice Sheets are in Gt yr^{-1} ($360 \text{ Gt} = 1 \text{ mm}$ of sea level). Sub-shelf basal melt and calving flux for Greenland are uncertain and variable, hence excluded. Sources: van den Broeke et al. (2016), Rignot et al. (2013)

MISI & MICI

- In Antarctica, outlet glaciers are vulnerable to marine ice sheet instability if they rest on bedrock that lies below sea level and slopes downward inland (Schoof, 2007), and to marine ice cliff instability if unstable ice cliffs with heights above 90 m are created following the collapse of ice shelves through hydrofracturing (DeConto and Pollard, 2016).
- Changes in oceanic conditions are the main triggers of these processes (Jacobs et al., 2011).

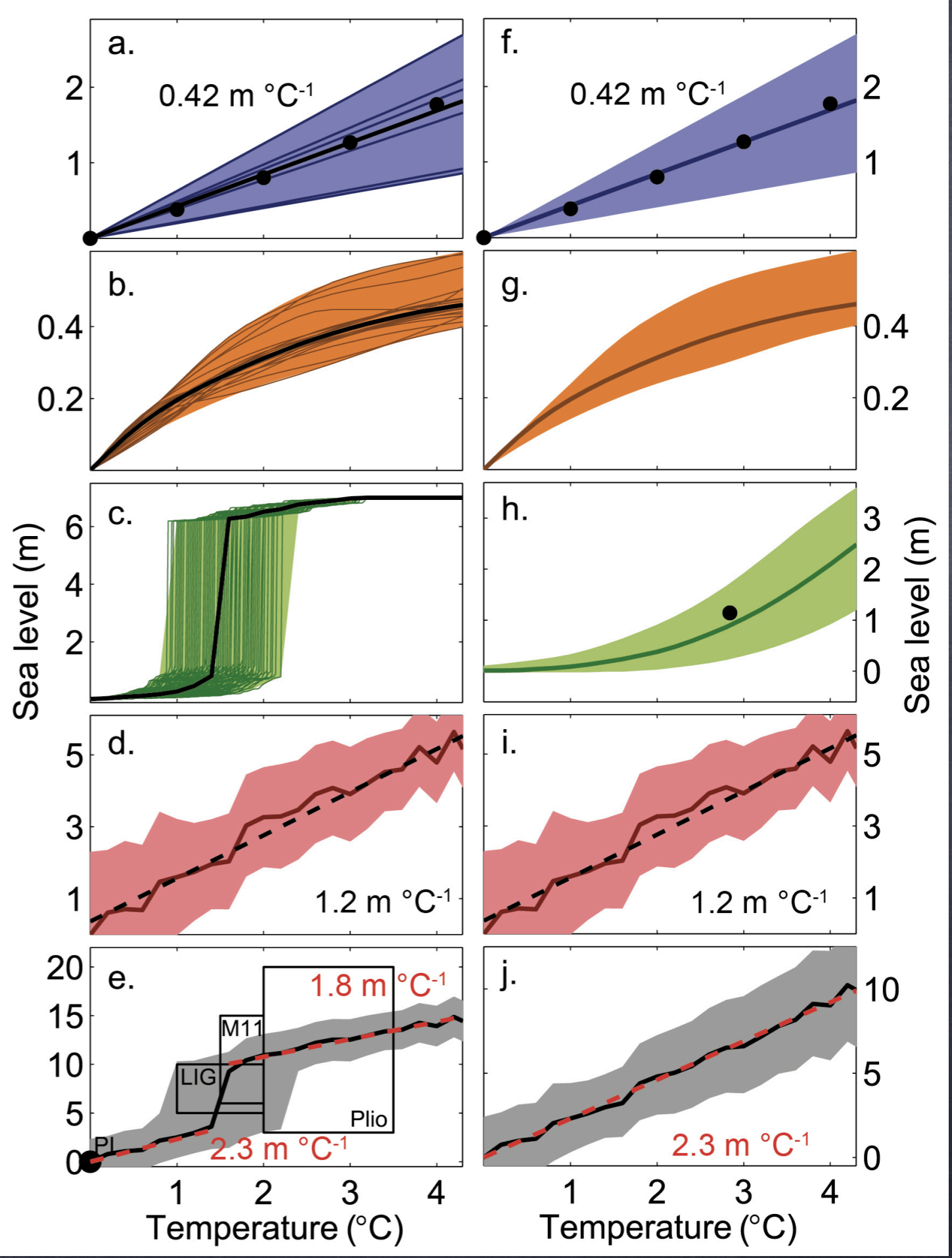
Total Change by
degrees warming
Oceans

Mountain Glaciers

Greenland

Antarctica

Total



Many kyr

2000yr



The former site of Okjökull, now known as simply Ok.

Rice University

A letter to the future

Ok is the first Icelandic glacier to lose its status as a glacier. In the next 200 years all our glaciers are expected to follow the same path. This monument is to acknowledge that we know what is happening and what needs to be done. Only you will know if we did it.

August 2019

415 ppm CO₂

-Andri Snær Magnason



Millennial change is hard to think about

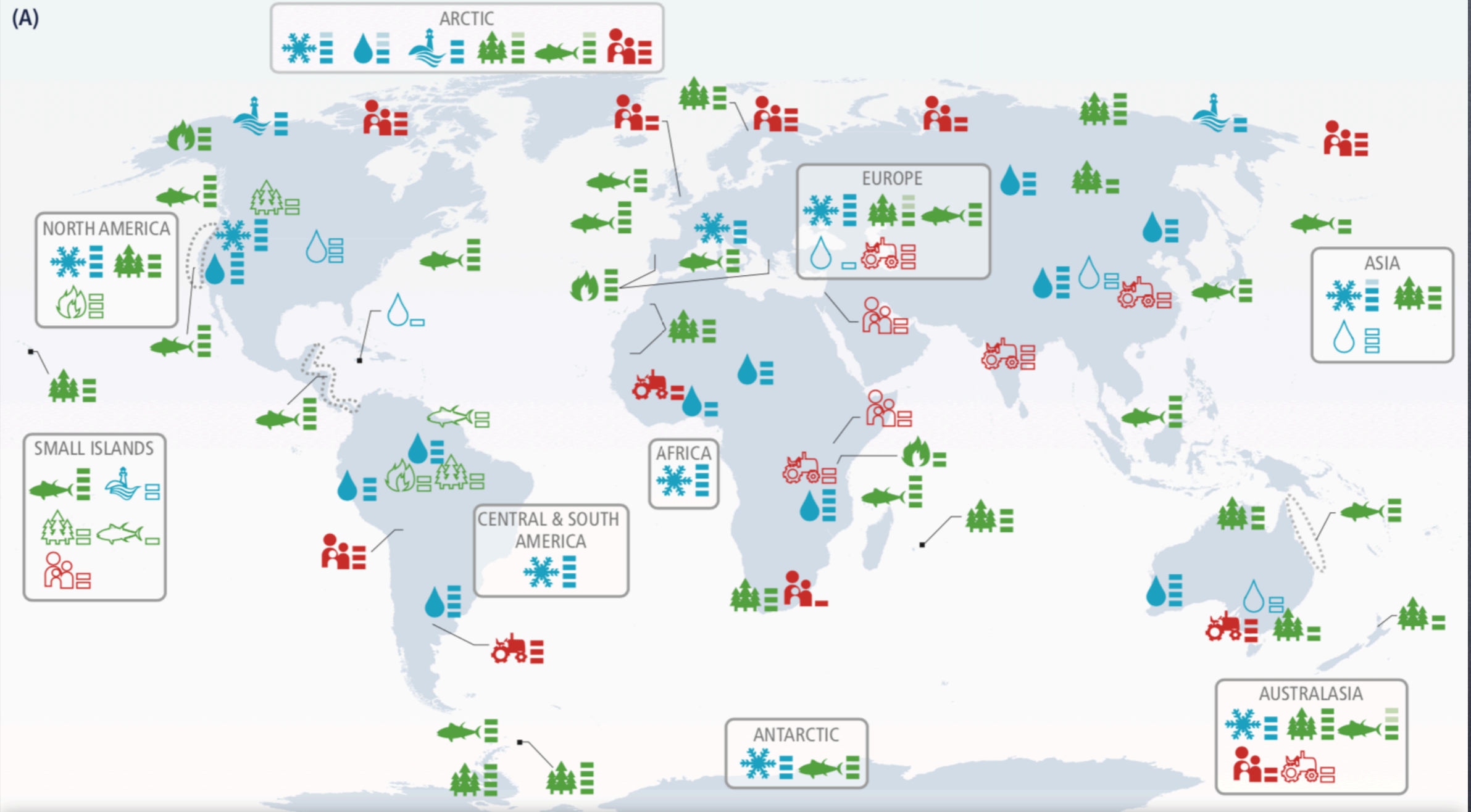
- 500 years in the future is 60 generations, 2x as far away as the USA or Brown is old.
- The "oldest" water in the abyssal Pacific was at the surface most recently during the Roman Empire.
- So, what does it mean societally that we expect 1-12m higher sea level someday?

The Moral and Psychological Deluge

"I'll grant that we've never seen an existential threat to all of humankind before. It's true that the planet itself has never become hostile to our collective existence. But history is littered with targeted—but no less deadly—existential threats for specific populations."

—Mary Annaise Heglar

Who is most at risk?



Confidence in attribution to climate change



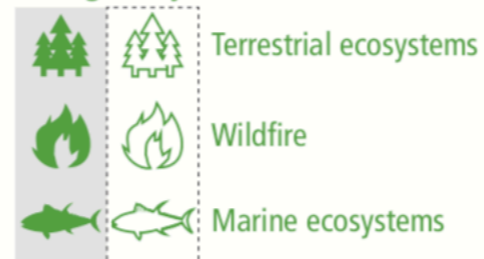
indicates confidence range

Observed impacts attributed to climate change for

Physical systems



Biological systems



Human and managed systems

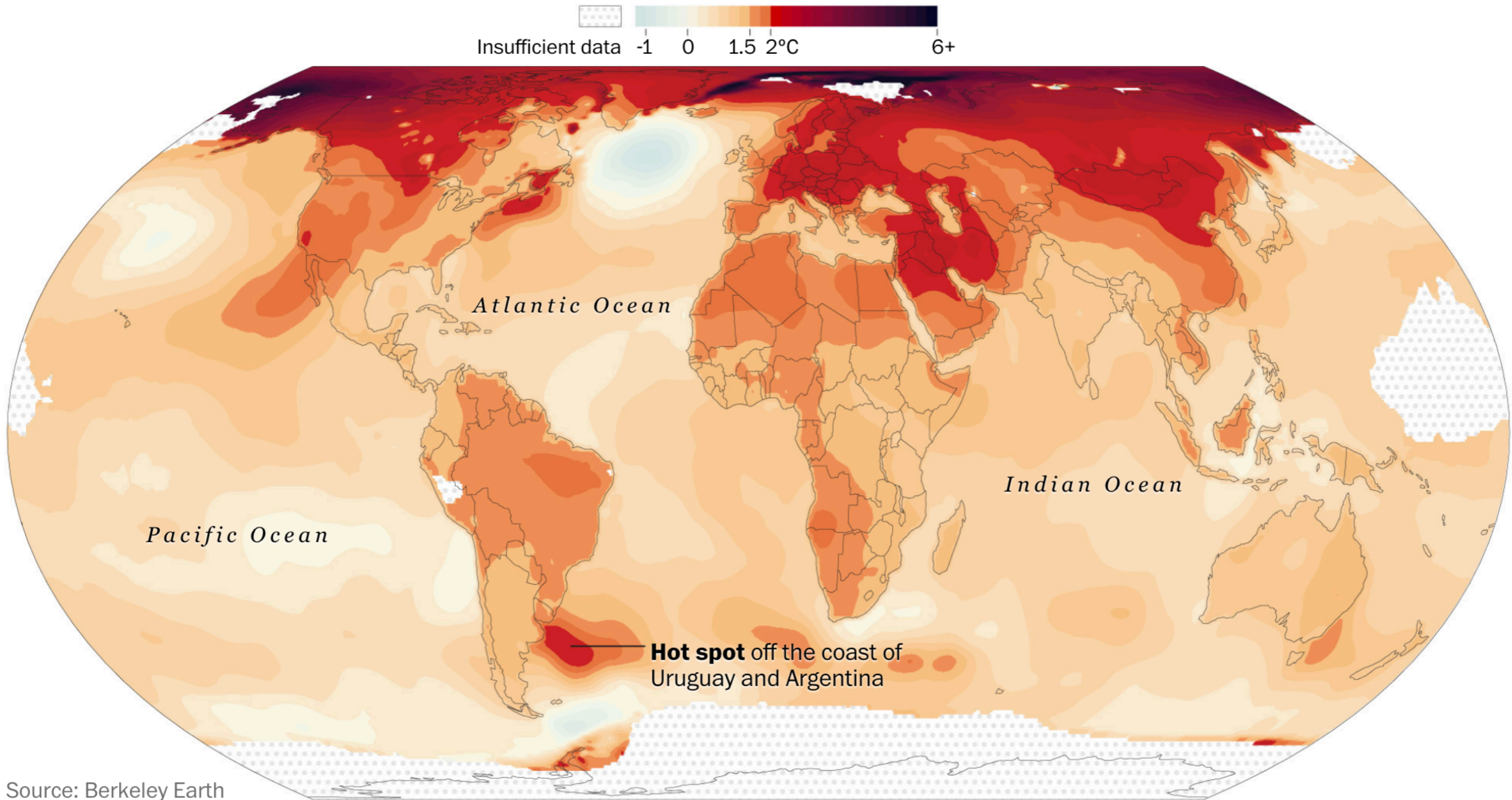


Regional-scale impacts

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

Who is most at risk?

Temperature change, 2014-2018 compared with 1880-1899



Visualization: Washington Post

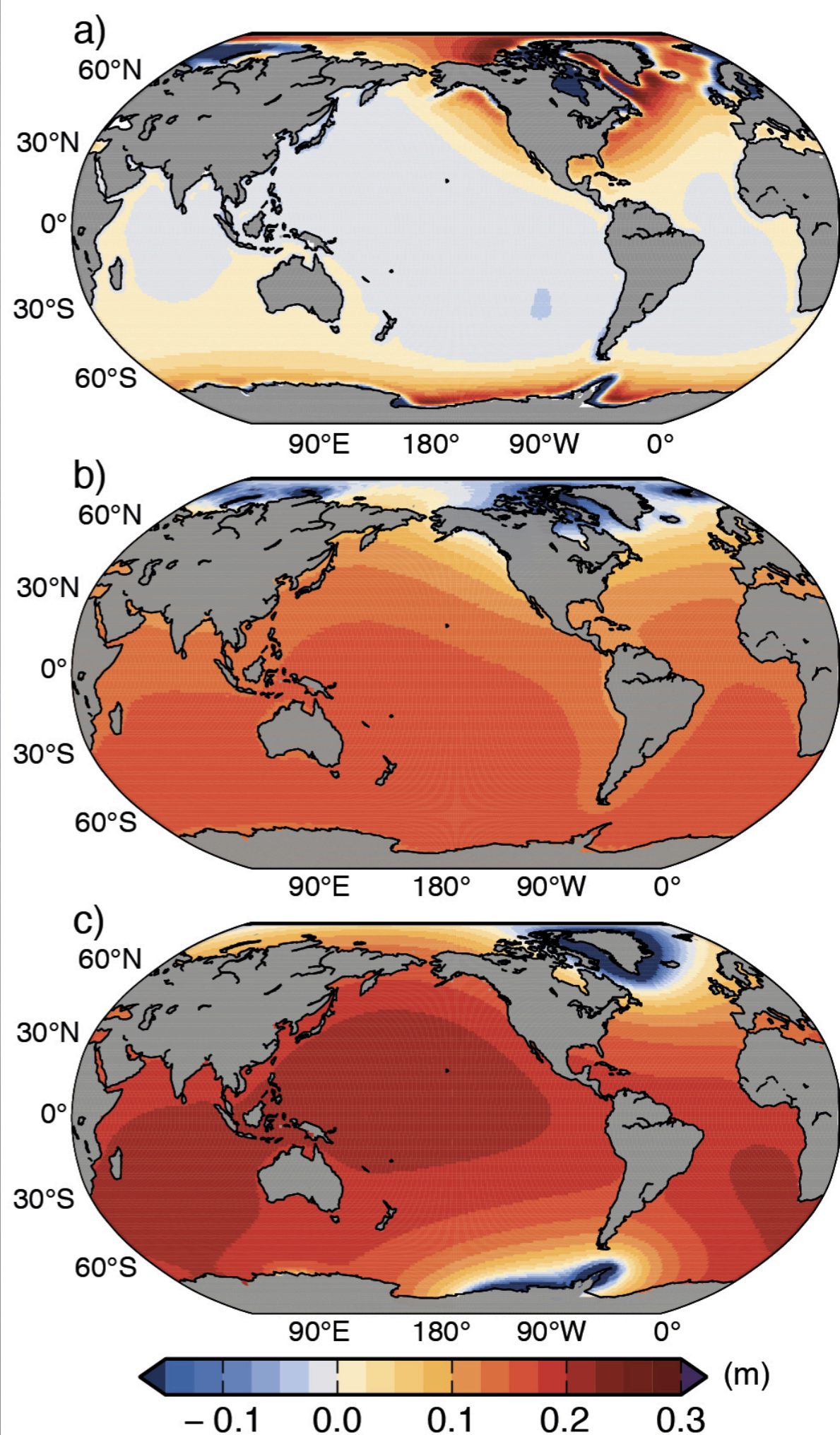
What about Regional Sea Level Rise?

- Global Mean Surface Temperature and Global Mean Sea Level don't hurt any ecosystems,
- It is their regional aspect that does.
- What goes into the regional sea level rise? (Hint: WAY more complex)

Glacial Isostatic Adjustment Pattern
(crust recovering from last ice age)

Glacier Melt Pattern

Ice Sheet Melt Pattern

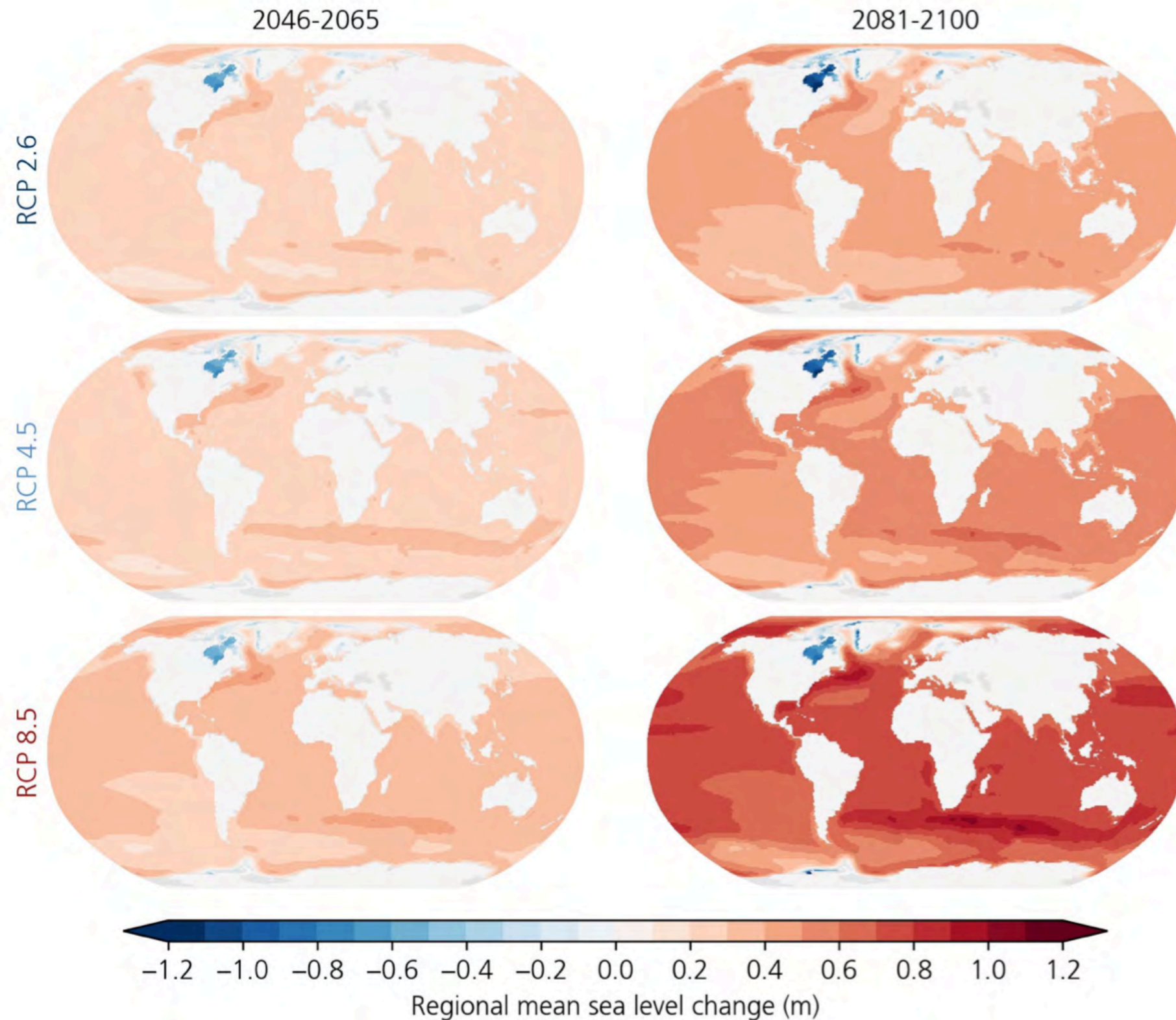


Relative (Regional) Sea Level vs. 1986-2005 by scenario: RCP2.5, 4.5, 8.5

FINAL DRAFT

Chapter 4

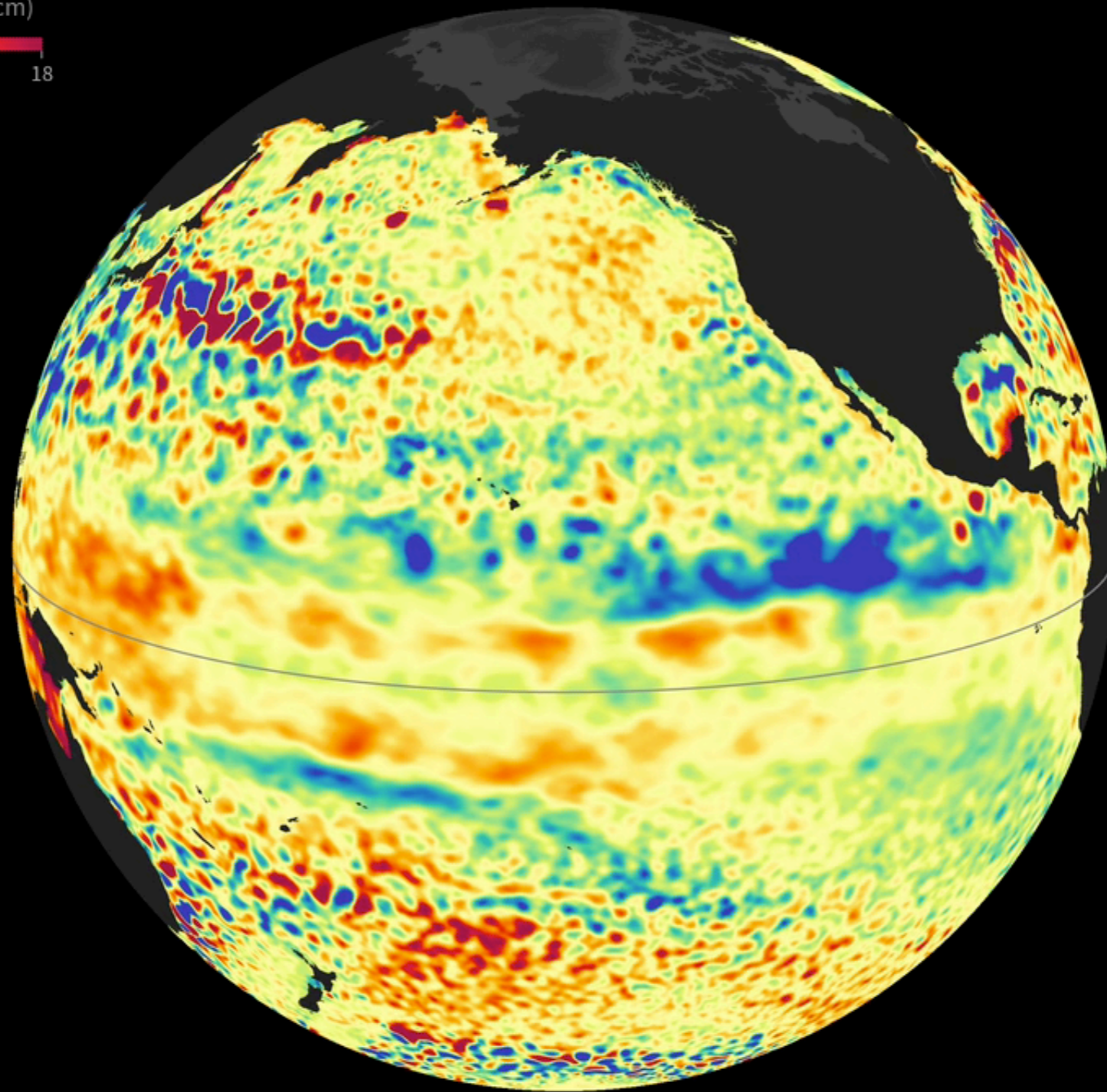
IPCC SR Ocean and Cryosphere



Sea Surface Height Anomaly (cm)



2014 Jan 1



Marit Jentoft-Nilsen: Visualizer

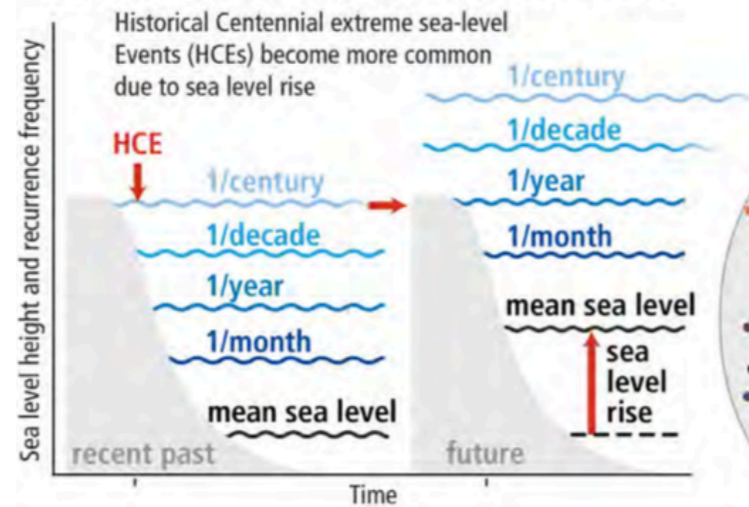
Please give credit for this item to:
NASA's Goddard Space Flight Center

Short URL to share this page:
<http://svs.gsfc.nasa.gov/30975>

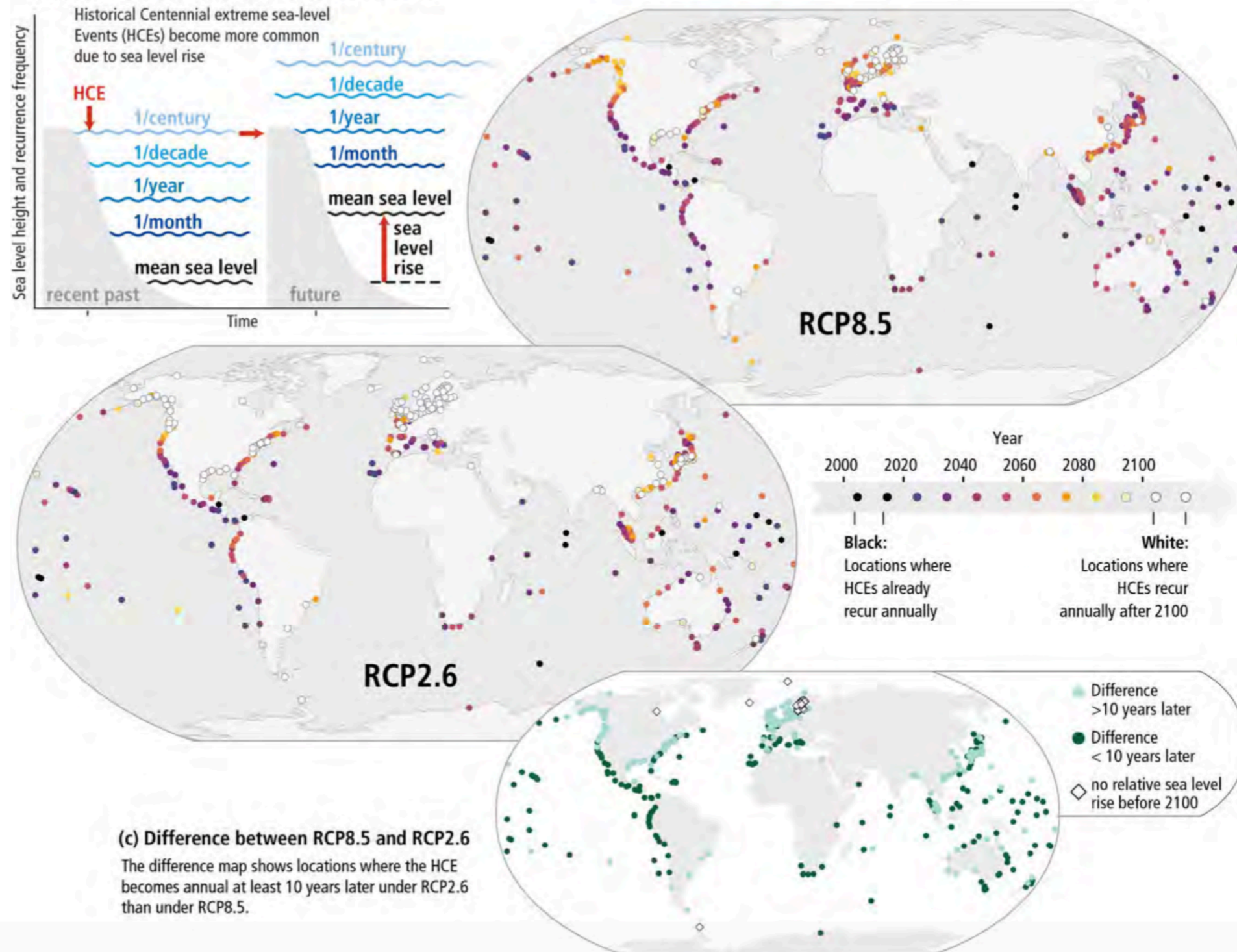
Extreme sea level events

Due to projected global mean sea level (GMSL) rise, local sea levels that historically occurred once per century (historical centennial events, HCEs) are projected to become at least annual events at most locations during the 21st century. The height of a HCE varies widely, and depending on the level of exposure can already cause severe impacts. Impacts can continue to increase with rising frequency of HCEs.

(a) Schematic effect of regional sea level rise on projected extreme sea level events (not to scale)



(b) Year when HCEs are projected to recur **once per year** on average



(c) Difference between RCP8.5 and RCP2.6
The difference map shows locations where the HCE becomes annual at least 10 years later under RCP2.6 than under RCP8.5.

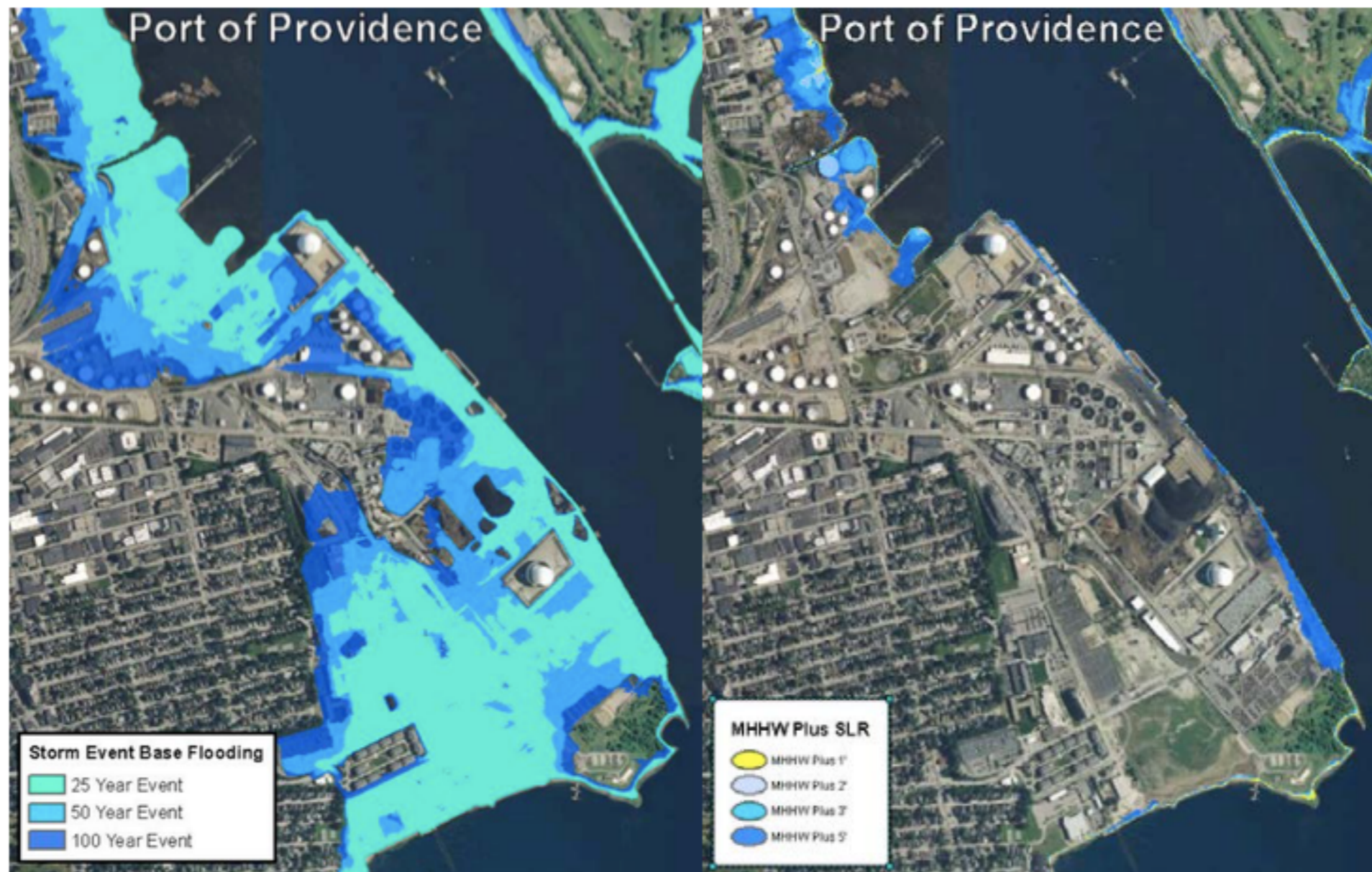


Figure 6 Flooding maps for the Port of Providence for the 25, 50, and 100 yr return period (left) and for 1, 2, 3, and 5 ft of sea level rise, relative to Mean High High Water(right).

Spaulding et al, URI/Sea Grant, 2016

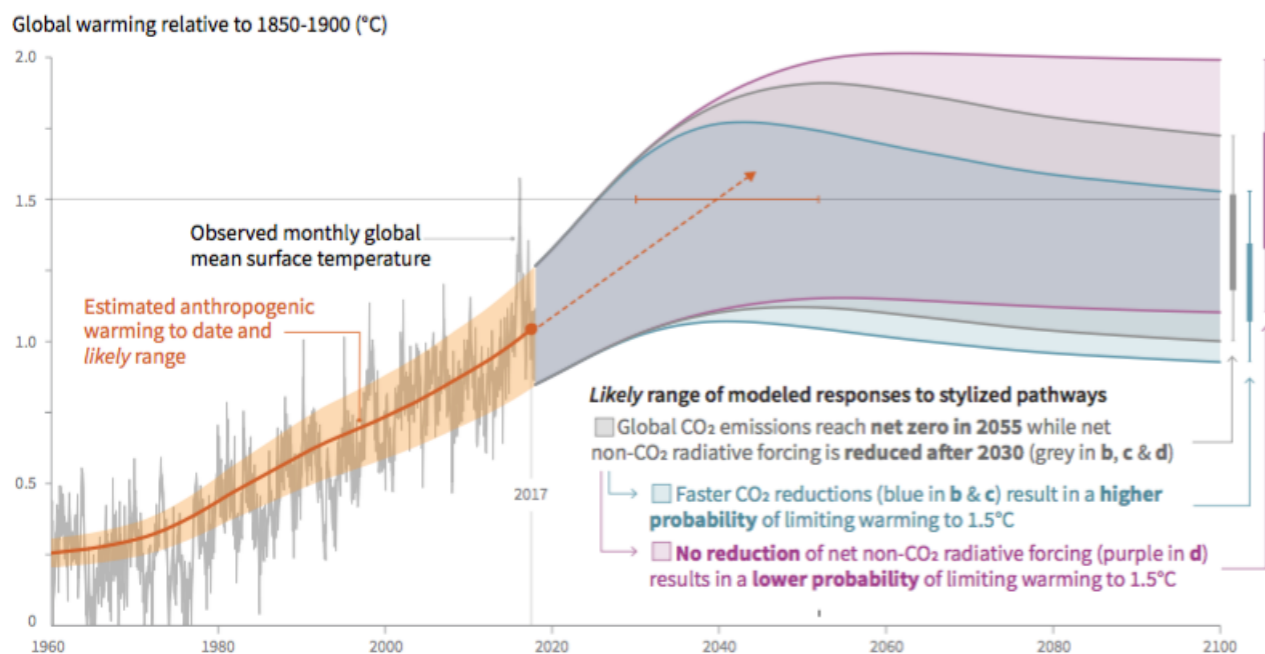
Conclusions

- Sea Level projections involve
 - Oceans, cryosphere, lithosphere & mantle, statistics, satellites, tides...
- However, they remain one of the best-understood impacts of climate change
- The committed sea level change due to warming to cumulative emissions will come, and it will be a lot.

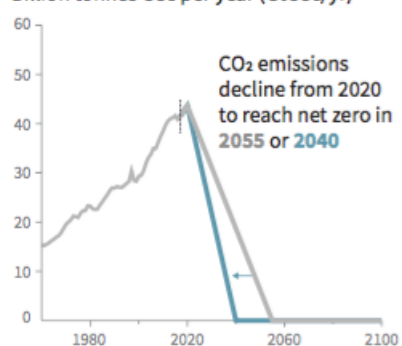
SR1.5

Cumulative emissions of CO₂ and future non-CO₂ radiative forcing determine the probability of limiting warming to 1.5°C

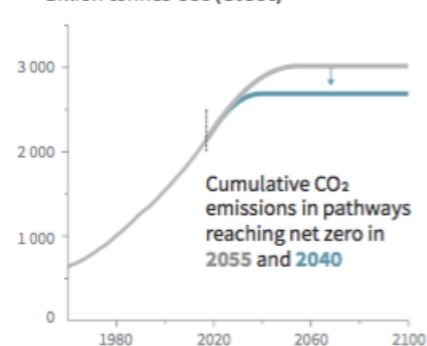
a) Observed global temperature change and modeled responses to stylized anthropogenic emission and forcing pathways



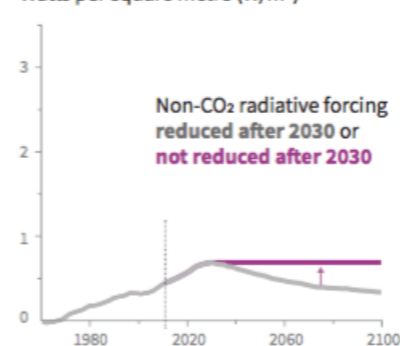
b) Stylized net global CO₂ emission pathways



c) Cumulative net CO₂ emissions



d) Non-CO₂ radiative forcing pathways



Faster immediate CO₂ emission reductions limit cumulative CO₂ emissions shown in panel (c).

Maximum temperature rise is determined by cumulative net CO₂ emissions and net non-CO₂ radiative forcing due to methane, nitrous oxide, aerosols and other anthropogenic forcing agents.

B2. By 2100, global mean sea level rise is projected to be around 0.1 metre lower with global warming of 1.5°C compared to 2°C (medium confidence). Sea level will continue to rise well beyond 2100 (high confidence), and the magnitude and rate of this rise depends on future emission pathways. A slower rate of sea level rise enables greater opportunities for adaptation in the human and ecological systems of small islands, low-lying coastal areas and deltas (medium confidence).

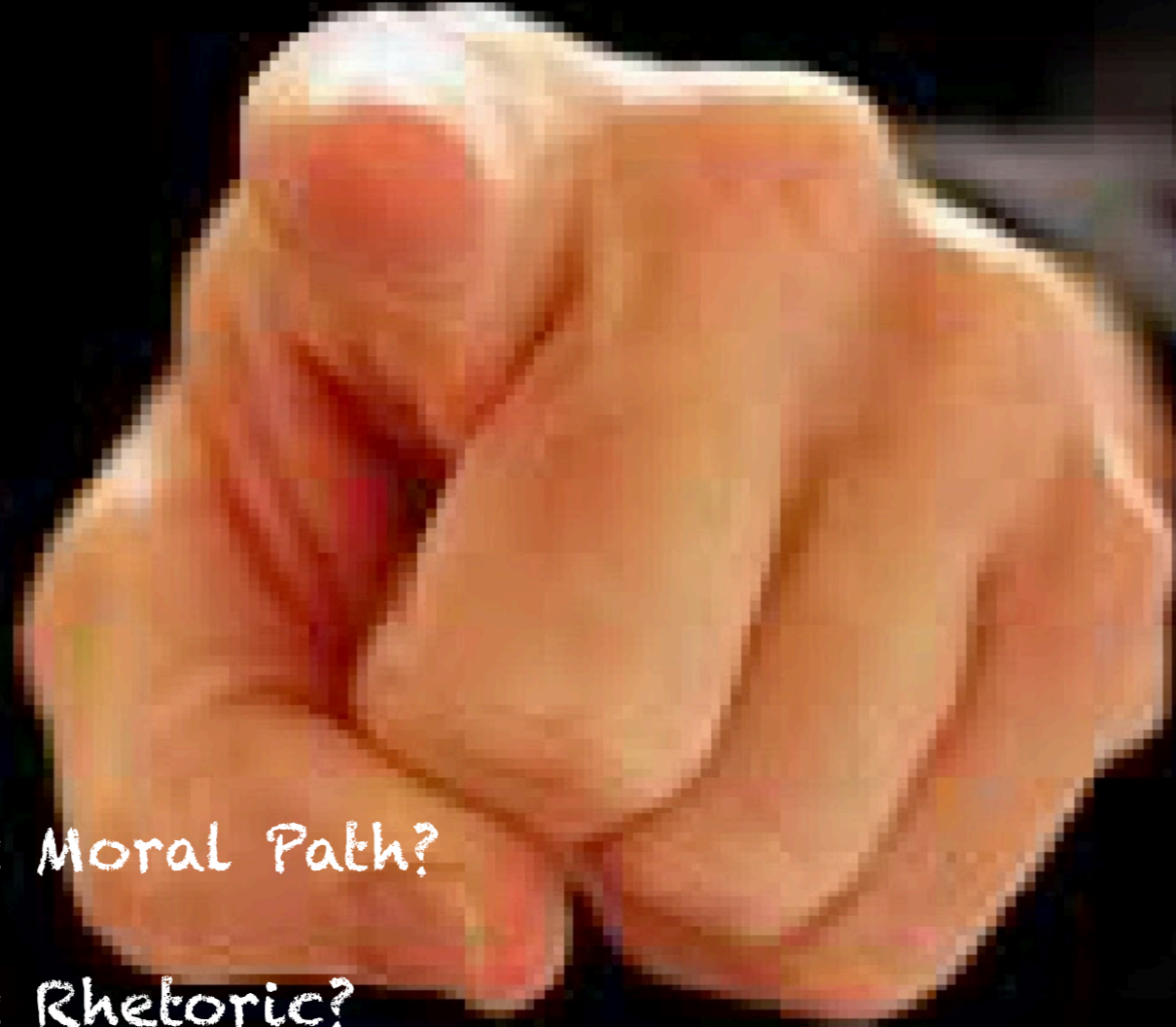
B4. Limiting global warming to 1.5°C compared to 2°C is projected to reduce increases in ocean temperature as well as associated increases in ocean acidity and decreases in ocean oxygen levels (high confidence). Consequently, limiting global warming to 1.5°C is projected to reduce risks to marine biodiversity, fisheries, and ecosystems, and their functions and services to humans, as illustrated by recent changes to Arctic sea ice and warm water coral reef ecosystems (high confidence).

D1. Estimates of the global emissions outcome of current nationally stated mitigation ambitions as submitted under the Paris Agreement would lead to global greenhouse gas emissions in 2030 of 52–58 GtCO₂eq yr⁻¹ (medium confidence). Pathways reflecting these ambitions would not limit global warming to 1.5°C, even if supplemented by very challenging increases in the scale and ambition of emissions reductions after 2030 (high confidence). Avoiding overshoot and reliance on future largescale deployment of carbon dioxide removal (CDR) can only be achieved if global CO₂ emissions start to decline well before 2030 (high confidence).

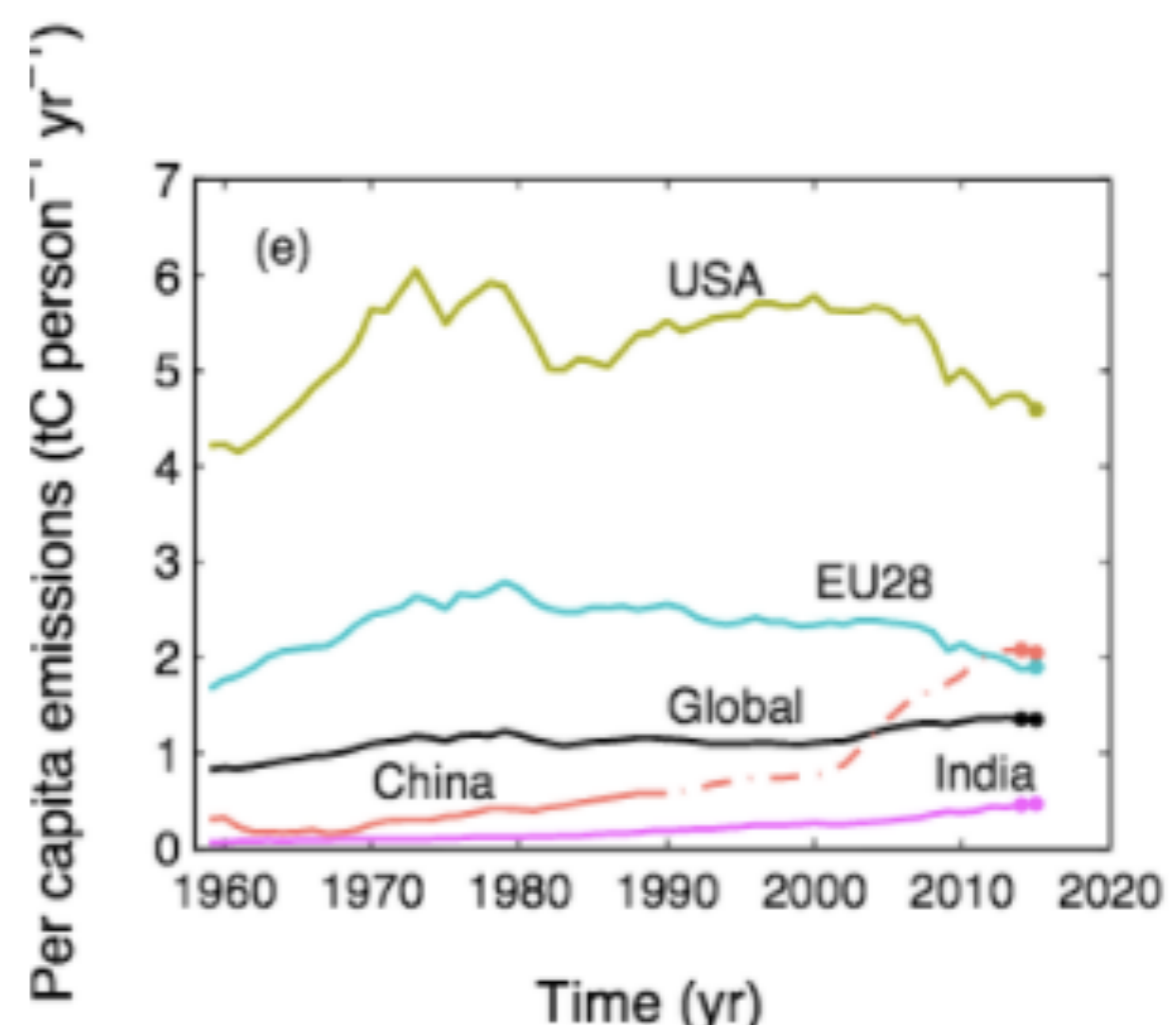
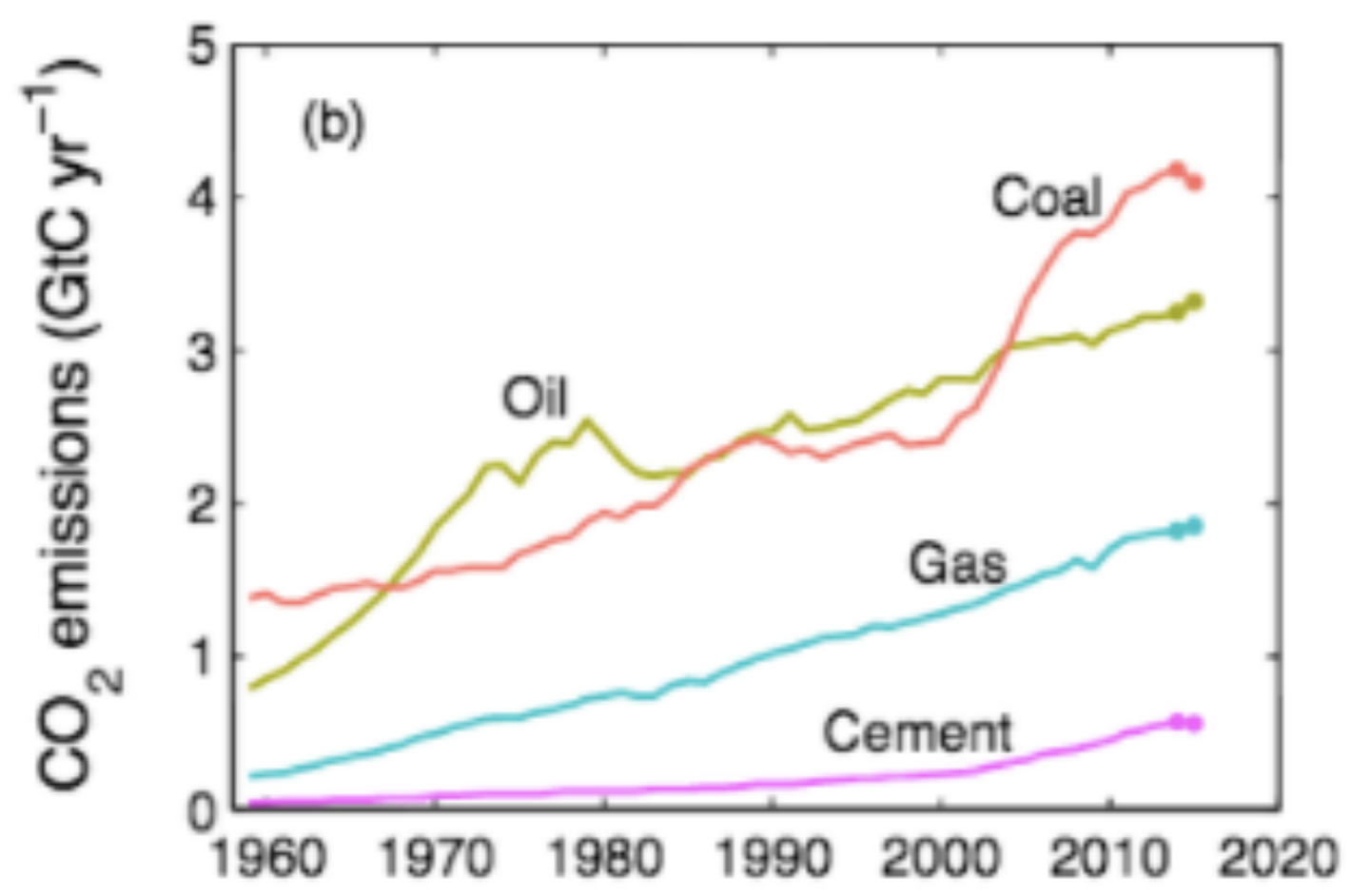
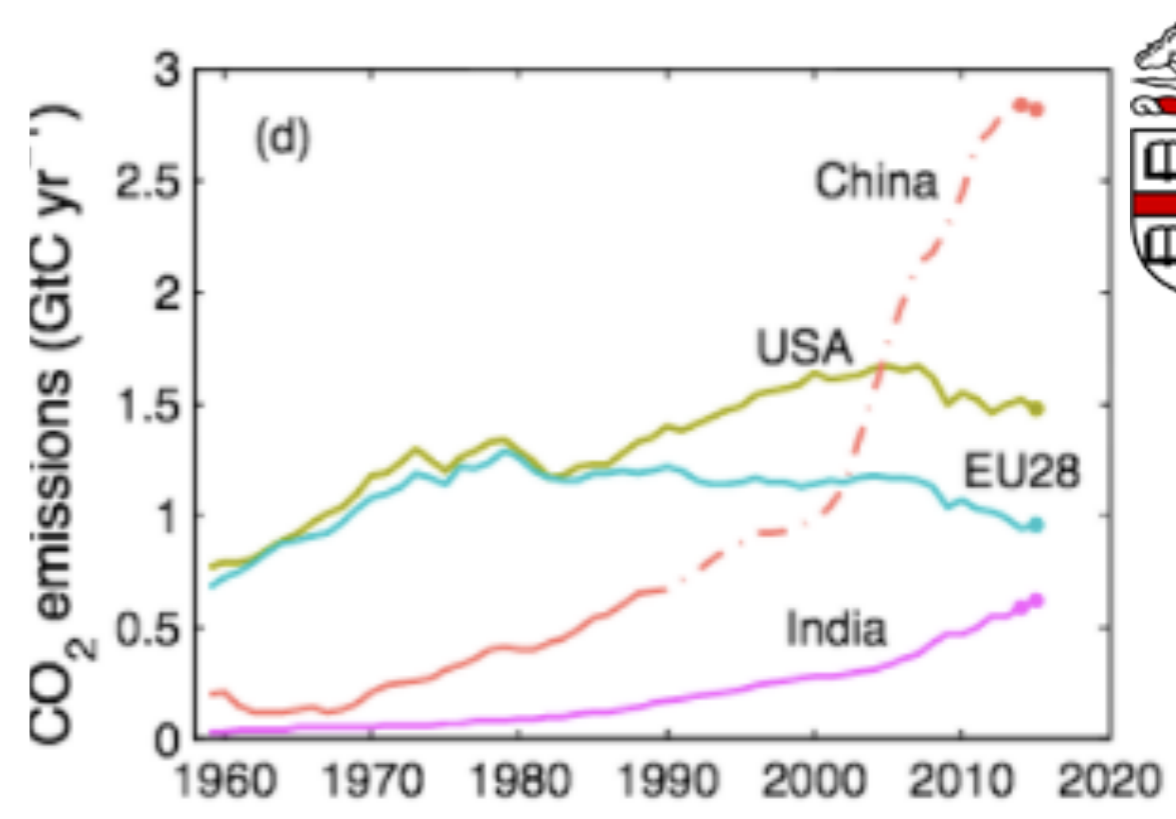
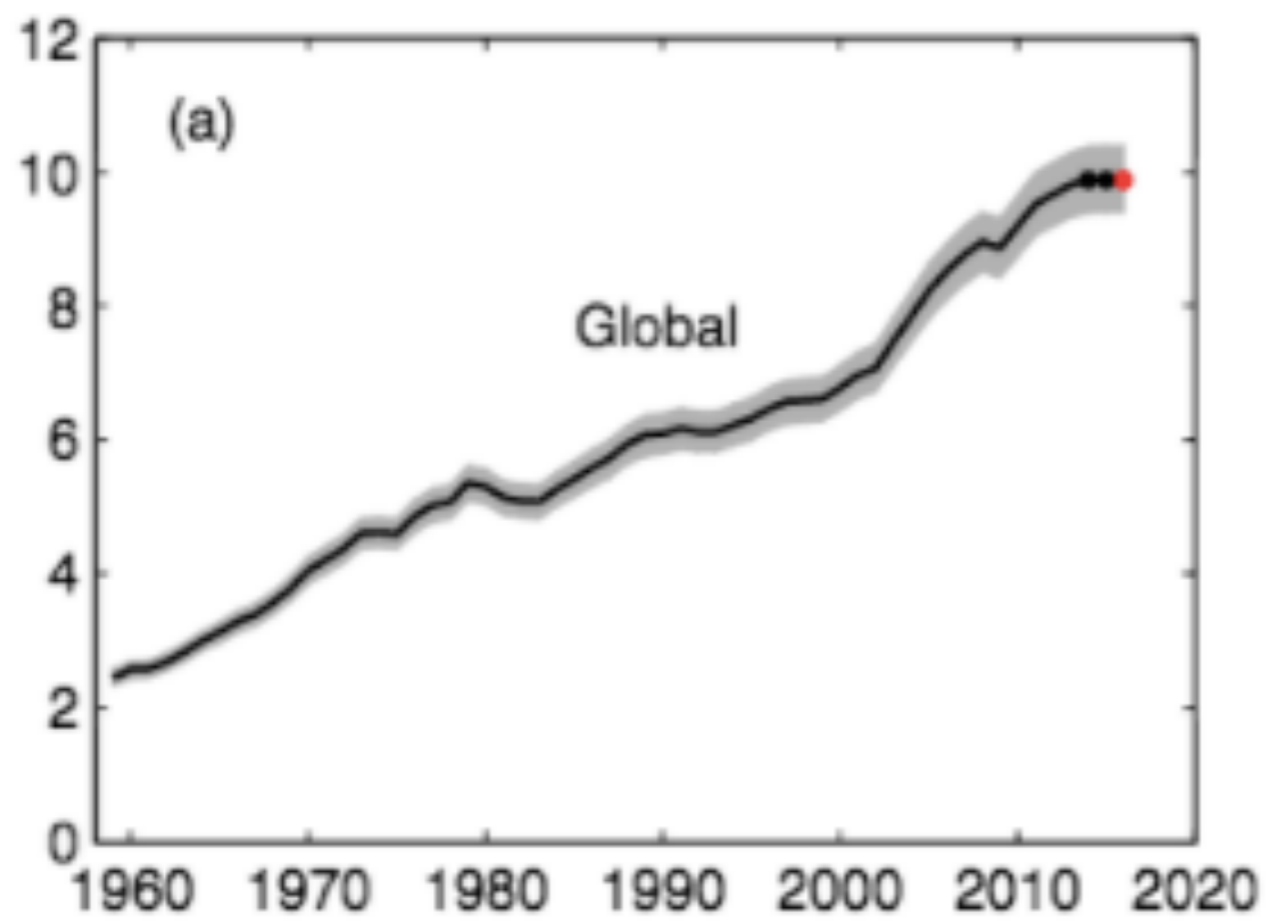
WHO IS...



- Individuals?
- Nations?
- Coal?
- Corporations?
- Me?
- You?
- Is Guilt the Right Moral Path?
- Is Guilt the Right Rhetoric?



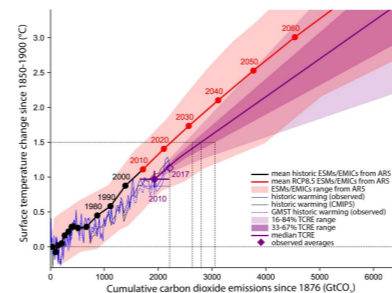
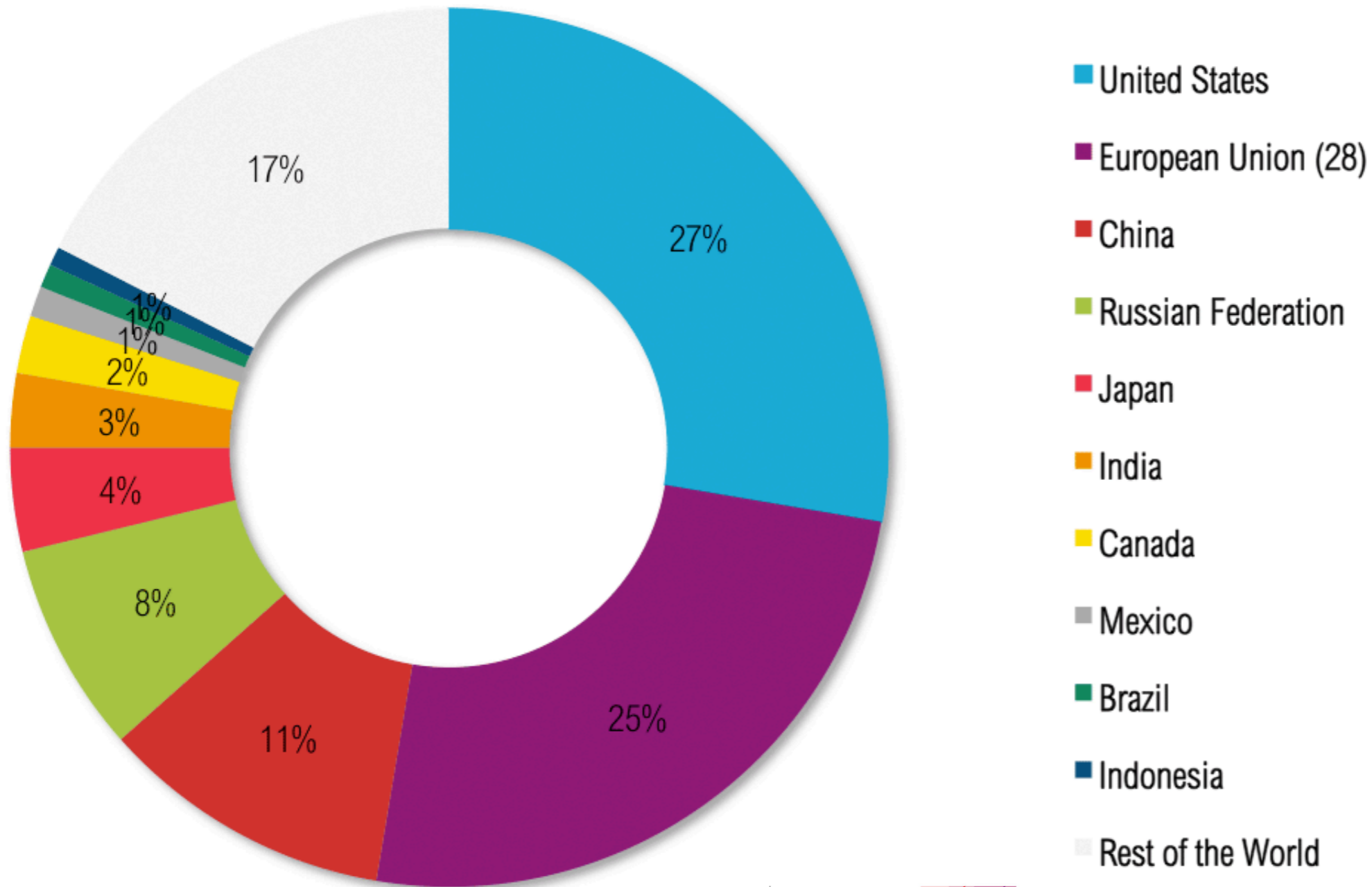
...TO BLAME?



Cumulative CO₂ Emissions 1850–2011 (% of World Total)



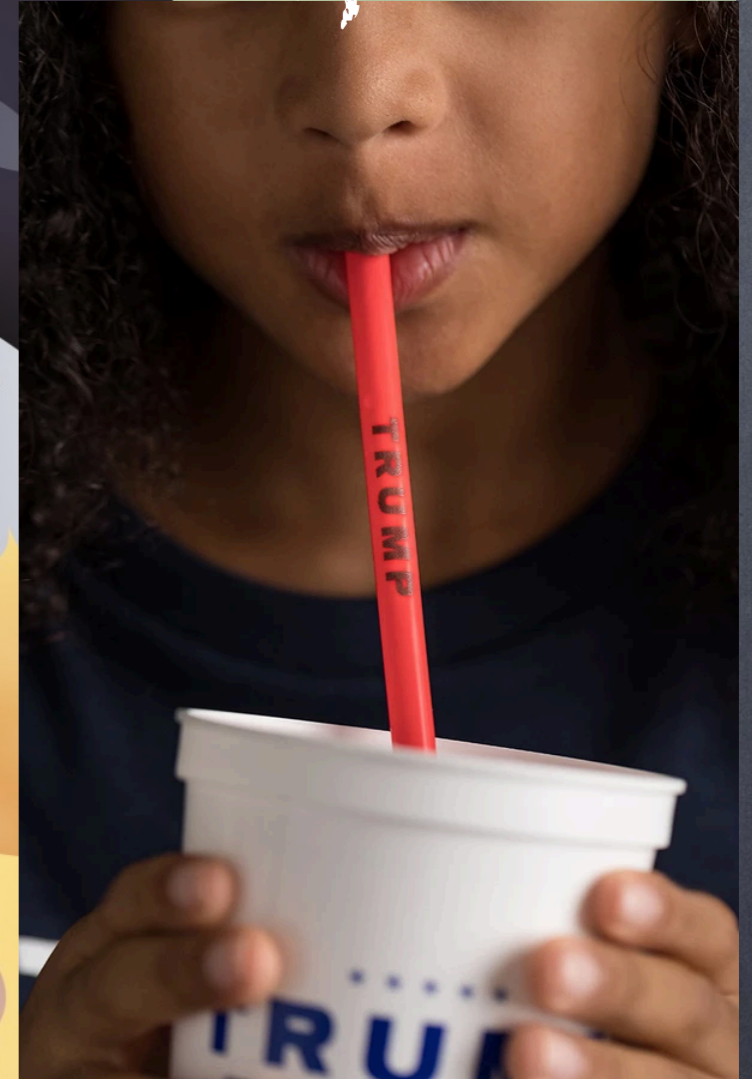
Cumulative = magnitude of change





Is Guilt the Right Rhetorical Argument?

defiance



doomsaying

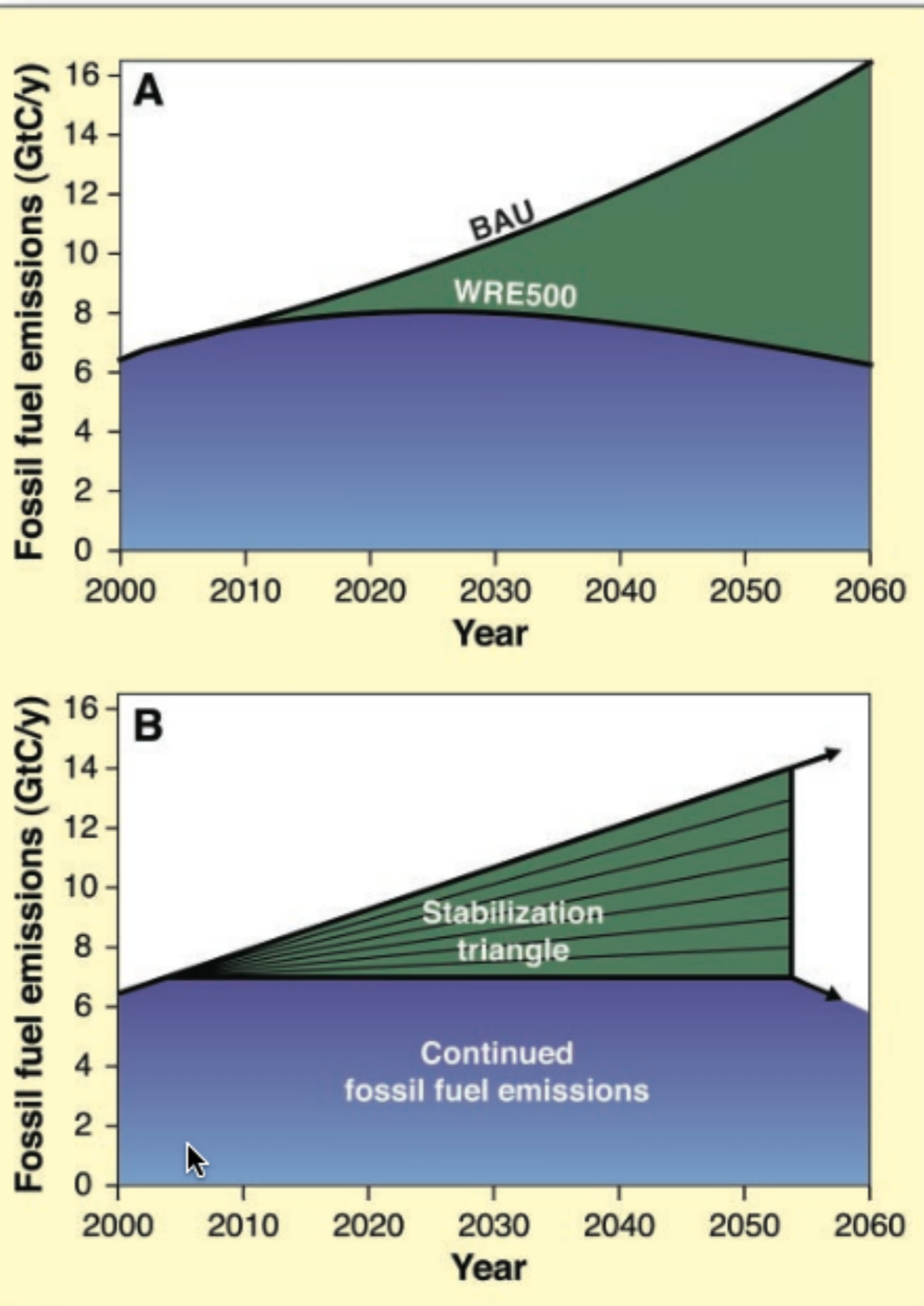
The climate apocalypse is coming. To prepare for it, we need to admit that we can't prevent it.

Good Rhetoric: Climate "Wedges"

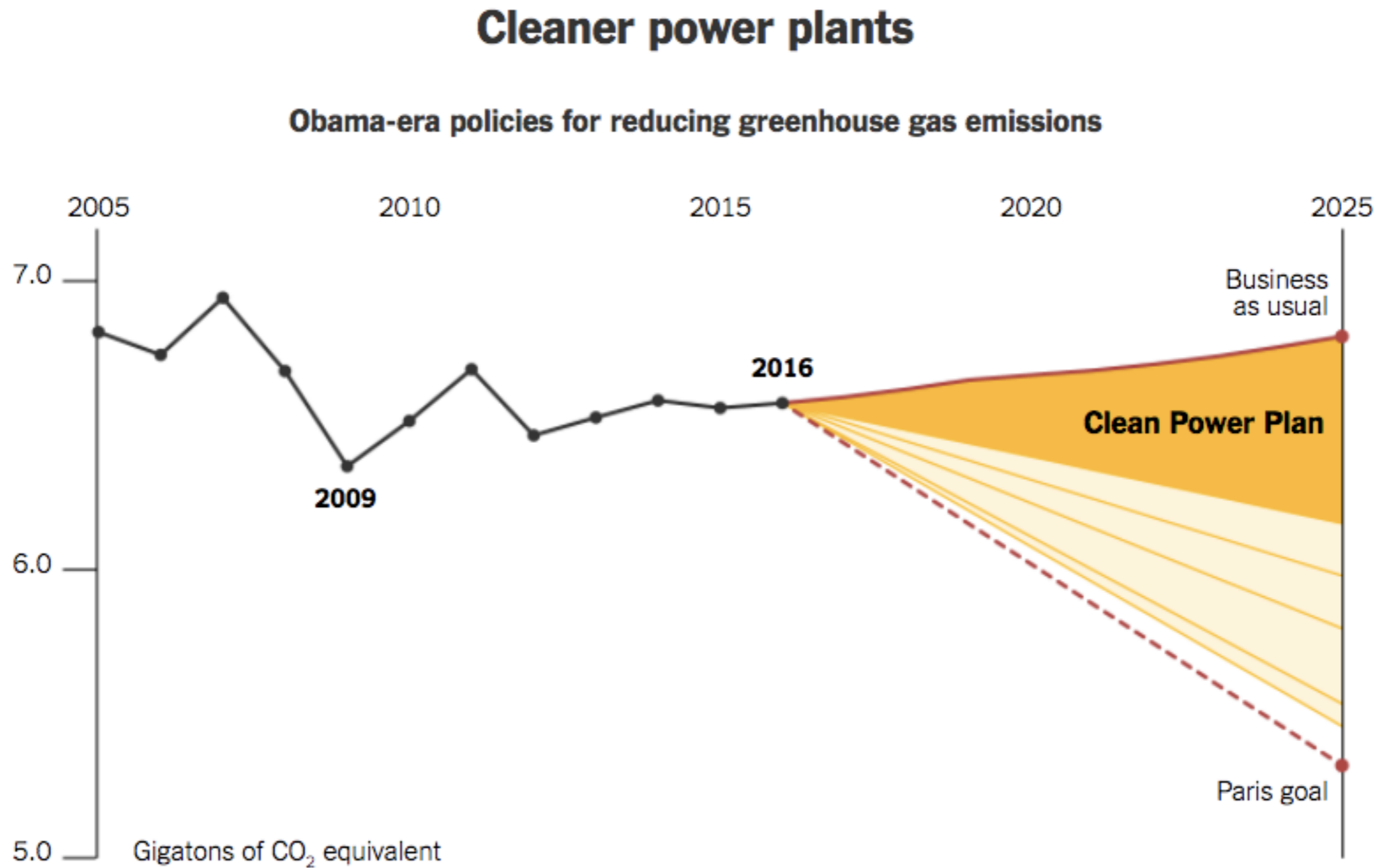
Pacala & Socolow
(2004)

Achievable "Bite"-sized
actions to reduce
emissions

Increase fuel economy for 2 billion cars from 30 to 60 mpg
Decrease car travel for 2 billion 30-mpg cars from 10,000 to 5000 miles per year
Cut carbon emissions by one-fourth in buildings and appliances projected for 2054
Decrease tropical deforestation to zero instead of 0.5 GtC/year, and establish 300 Mha of new tree plantations (twice the current rate)
Replace 1400 GW 50%-efficient coal plants with gas plants (four times the current production of gas-based power)

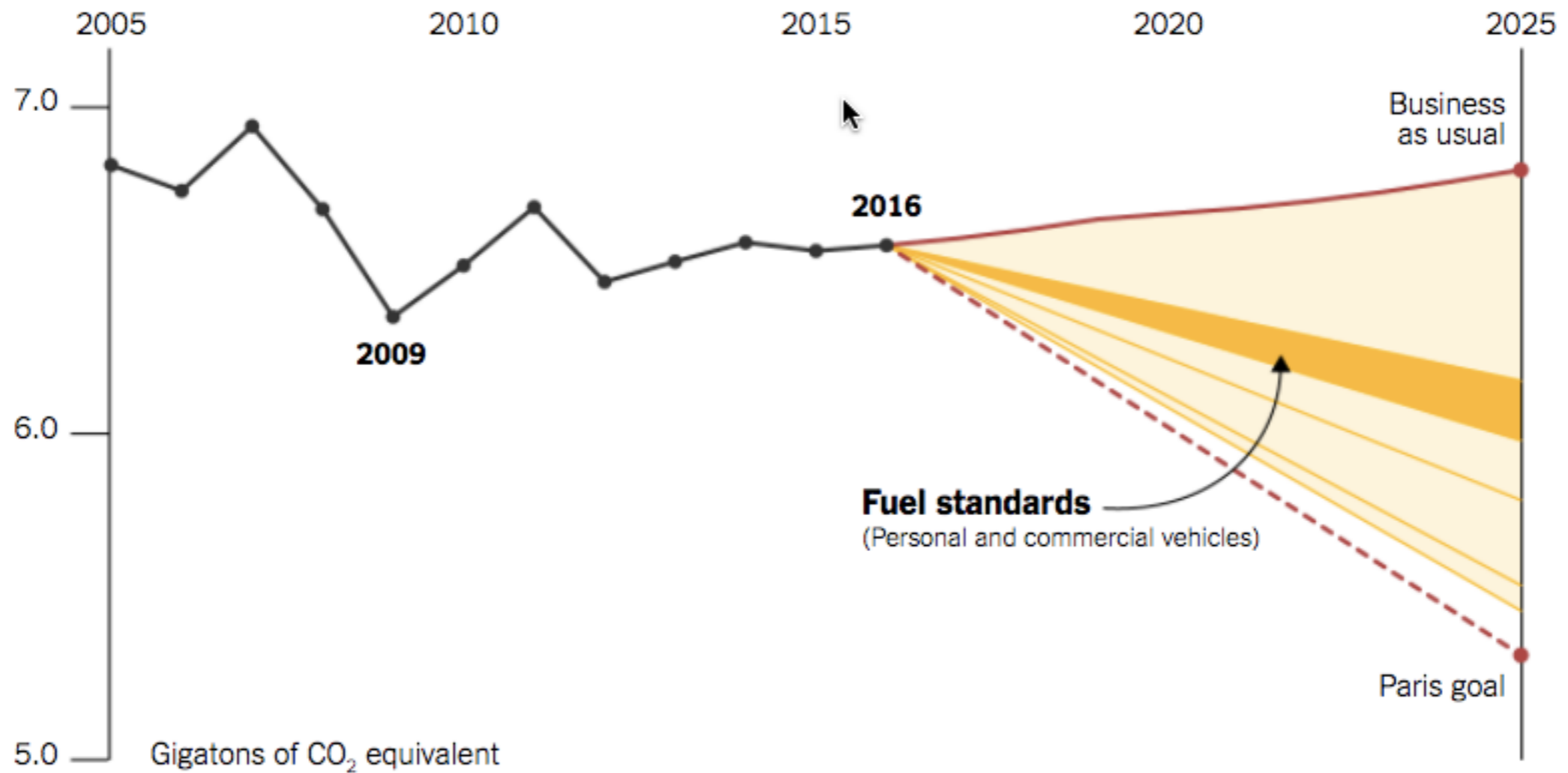


Obama-Era Plans to satisfy Paris Agreement

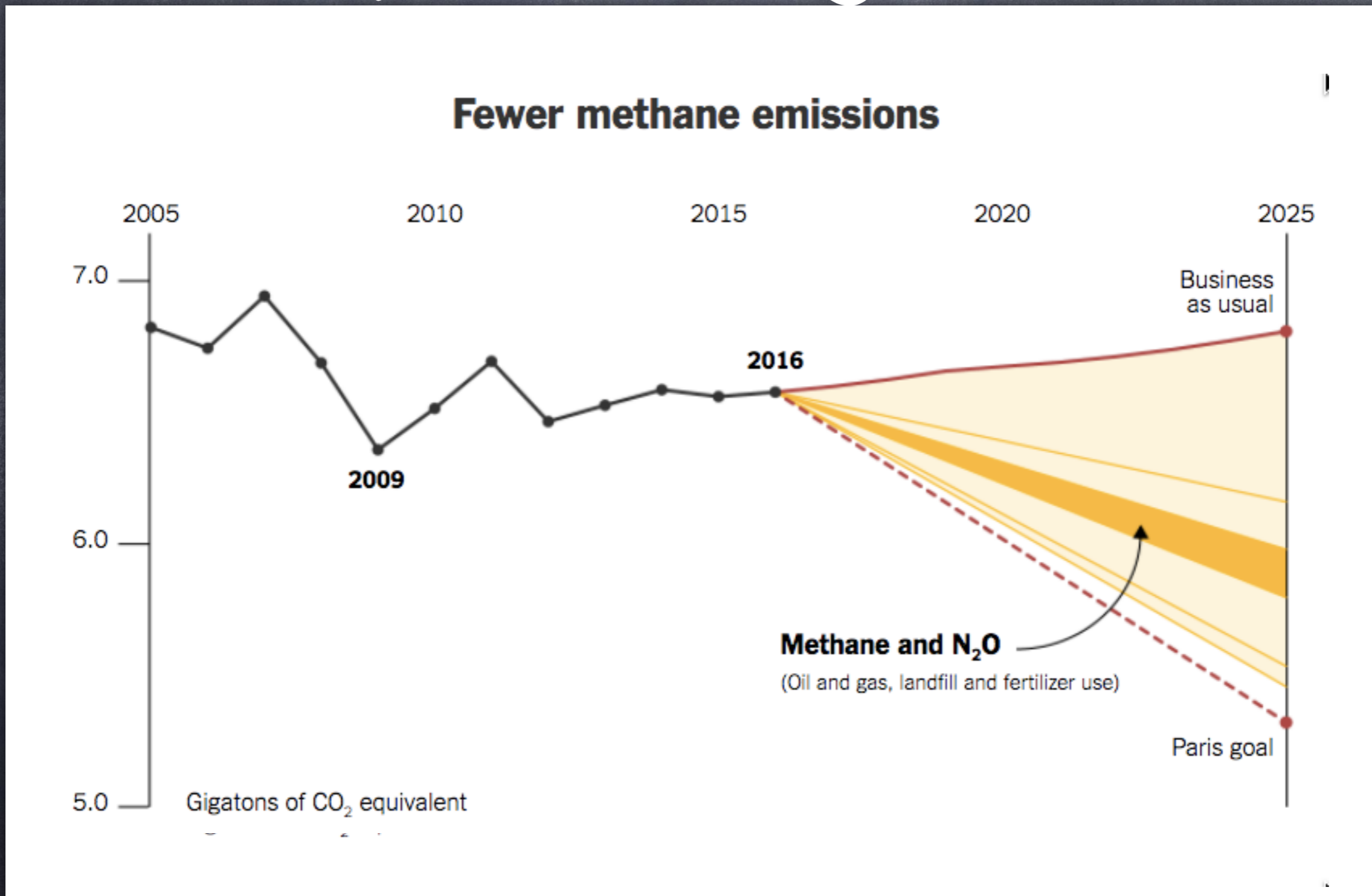


Obama-Era Plans to satisfy Paris Agreement

More efficient cars

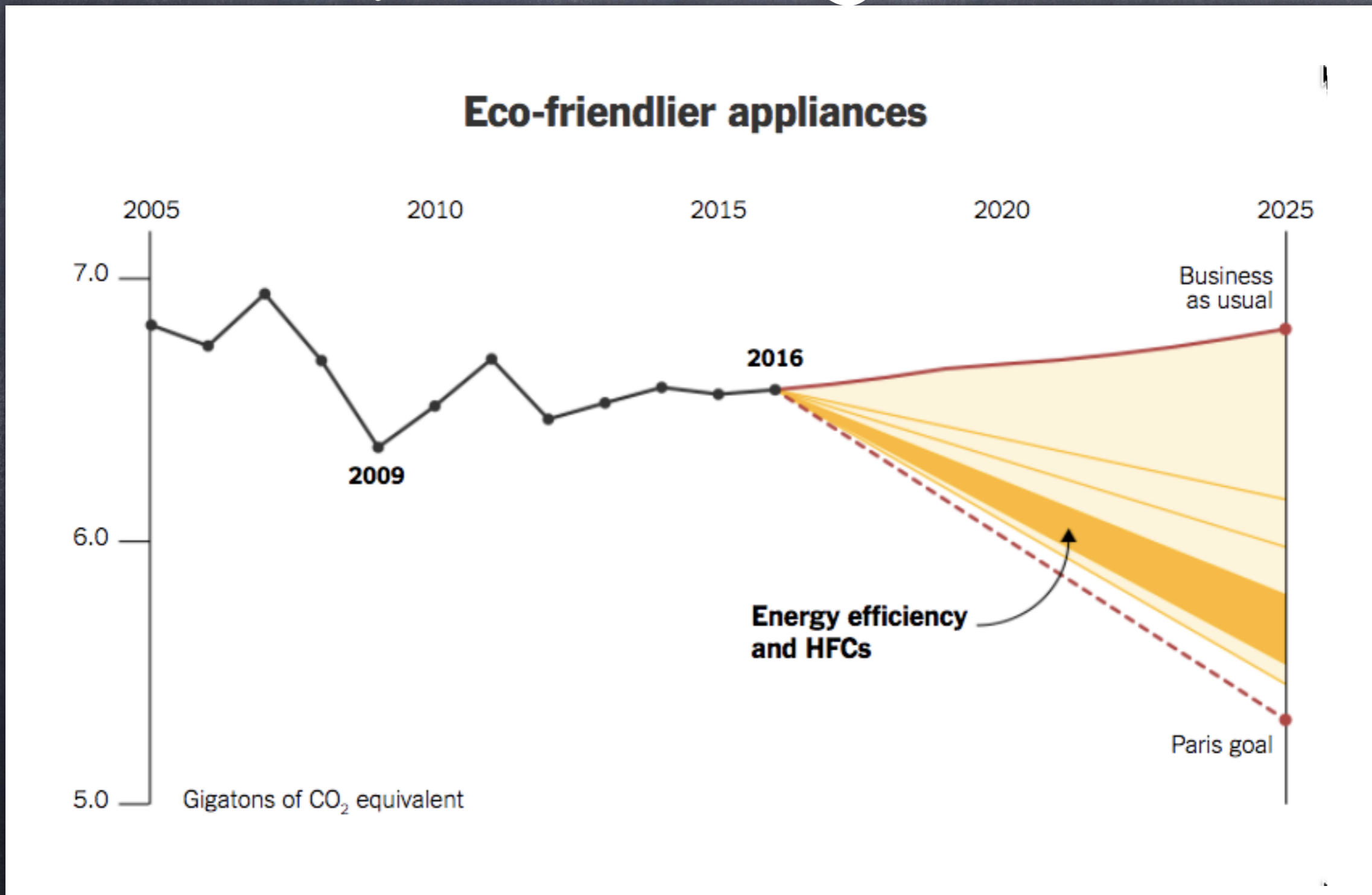


Obama-Era Plans to satisfy Paris Agreement



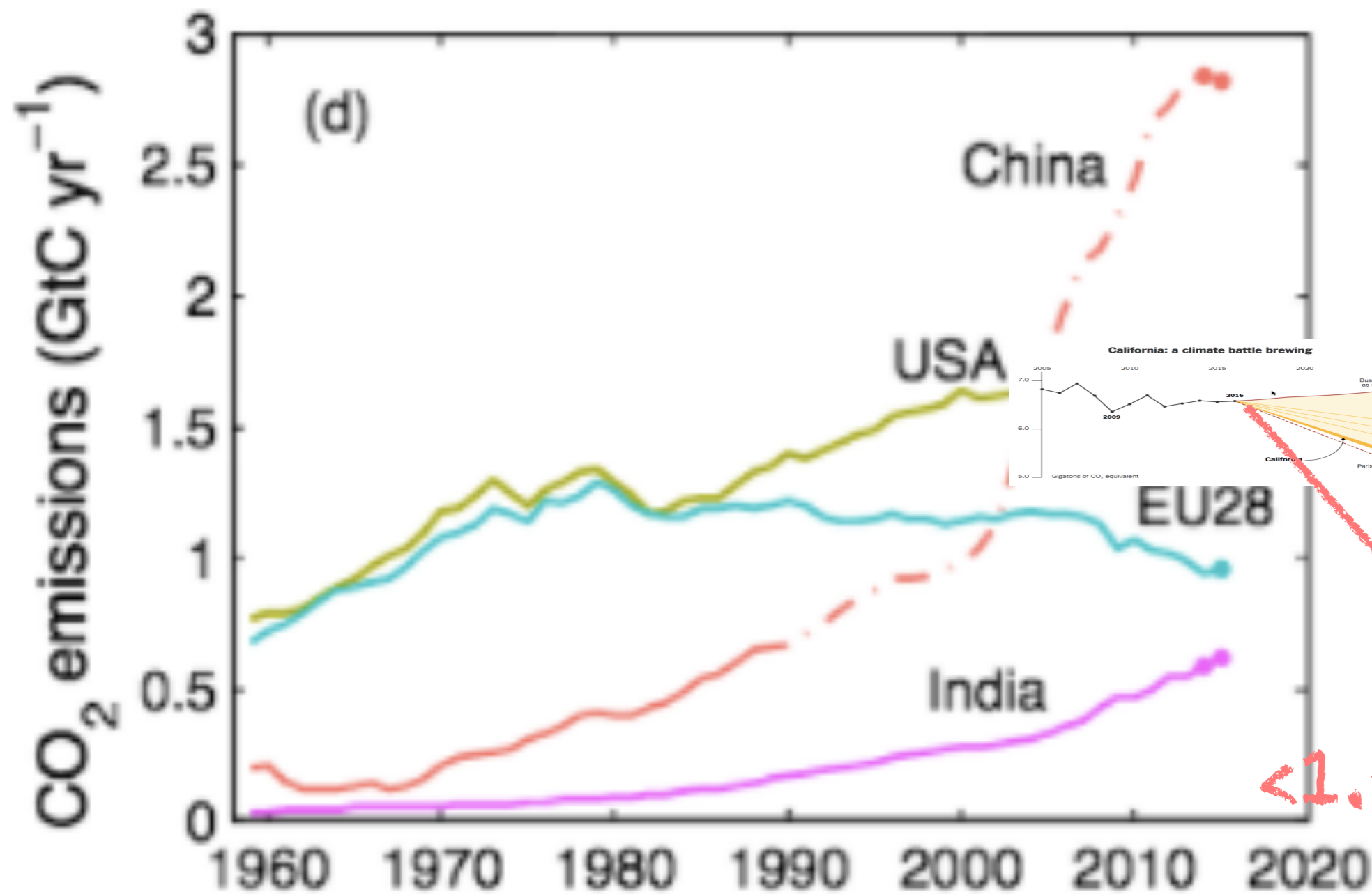
Source: NYTimes

Obama-Era Plans to satisfy Paris Agreement



Source: NYTimes

Obama-Era plans do not lead to net zero emissions in time to stay near 1.5C.

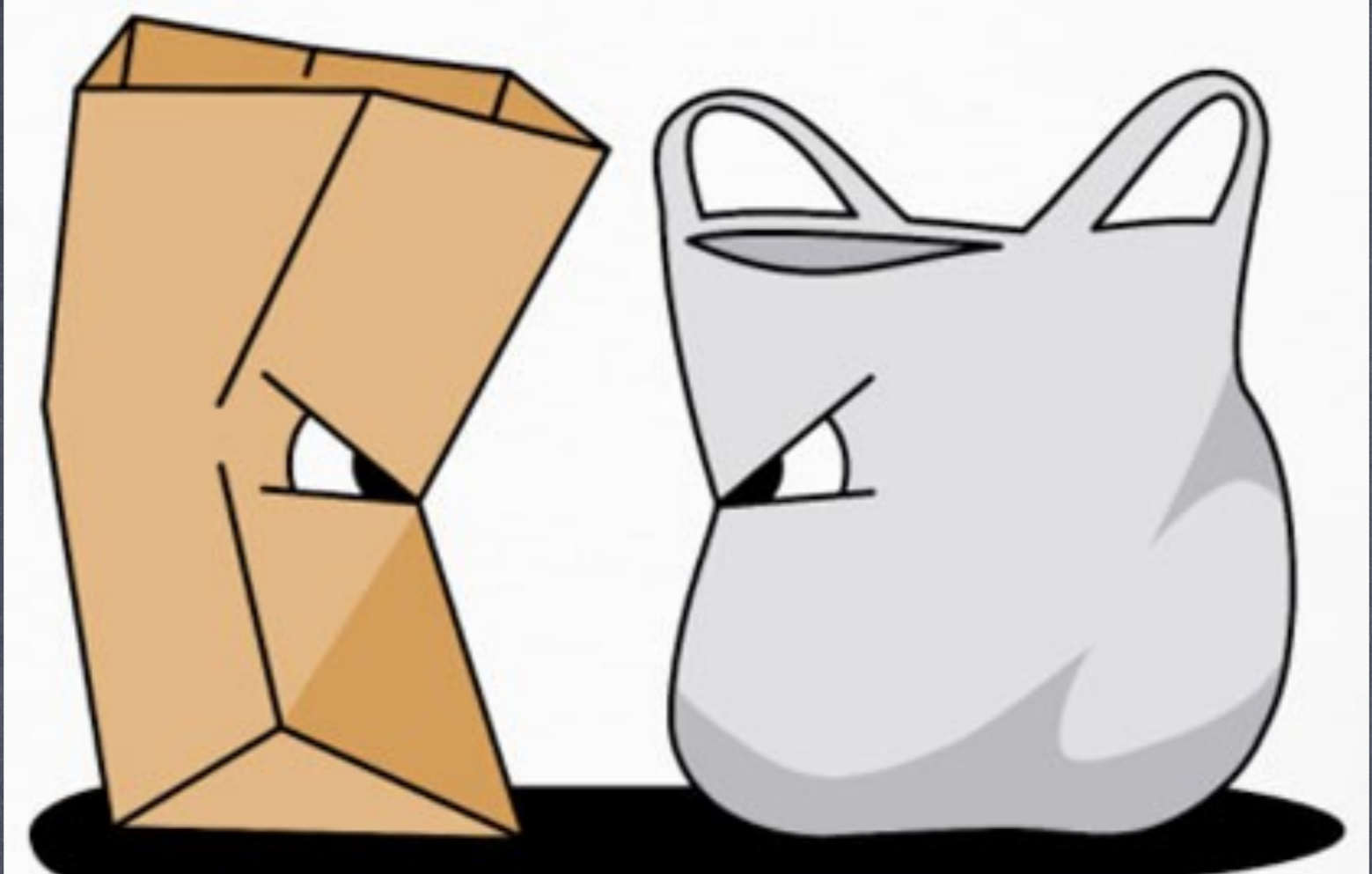


Source: NYTimes, carbonbrief.org



Doctor Who: The Silence





ecoenclose.com



independentaustralia.net



Kate Shortman and Isabelle Thrope
[youtube.com](https://www.youtube.com)



Hypocritical Scientists and Environmentalists?

INVESTOR'S BUSINESS DAILY®

Sign In

EDITORIALS

Al Gore's Climate Change His Energy-Sucking

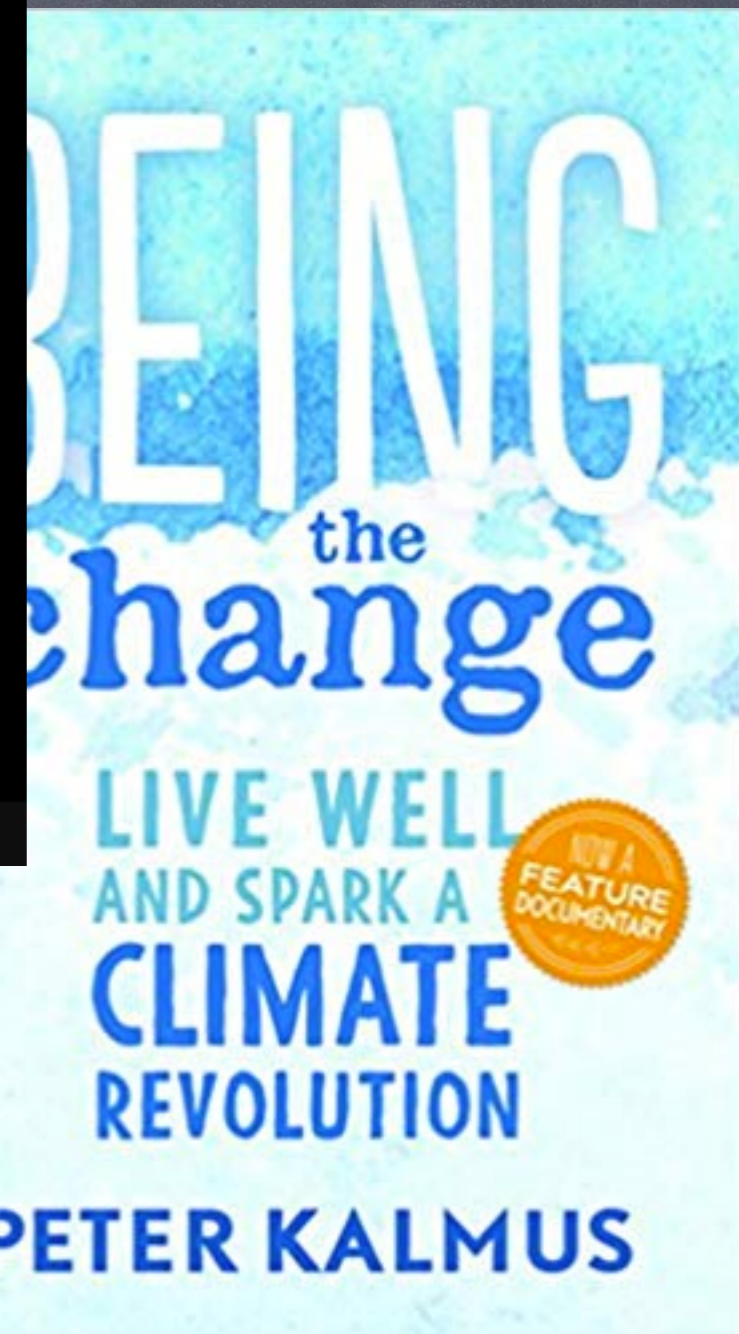
Inconvenient Truth: In a recent interview
The electricity bills for his home in Tennessee

CNN's Jake Tapper asked Gore to respond to
criticism we hear from conservatives and
or Leonardo DiCaprio," Tapper said, "the

#flyingle

#remotework

Is this really part
of my job?





Climate disinformation and gaslighting is real.



Brulle



Roberts



Whitehouse

Brown & RI are doing a
good job exposing the \$\$
and mechanisms behind it.

We can't accept the blame, so we forget, block,
or deny which actions cause climate change,
but maybe it shouldn't be so hard to keep track



The New York Times

Opinion

OP-ED CONTRIBUTORS

A Conservative Case for Climate Action

By Martin S. Feldstein, Ted Halstead and N. Gregory Mankiw

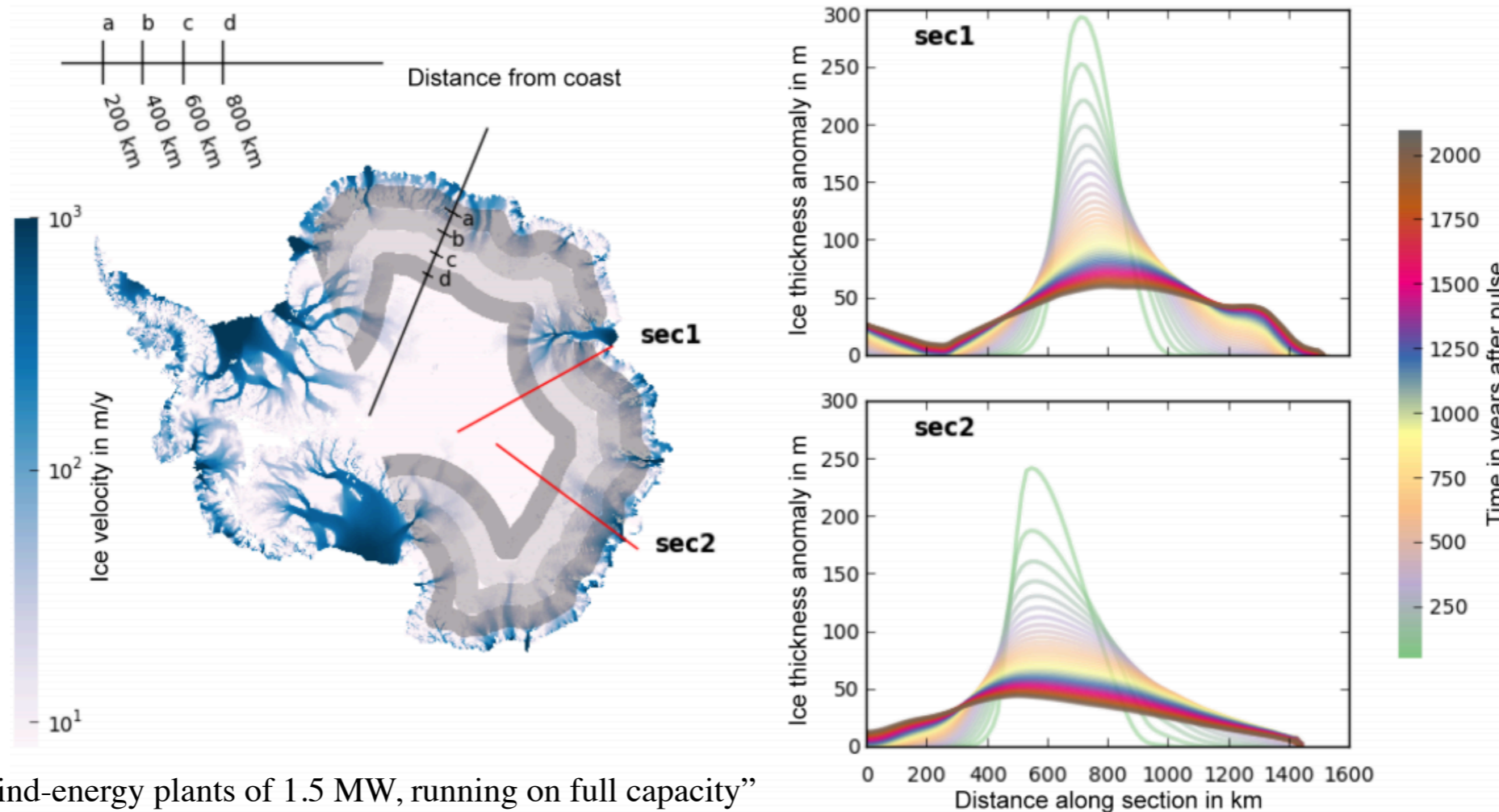
Feb. 8, 2017

Geoengineering?



204

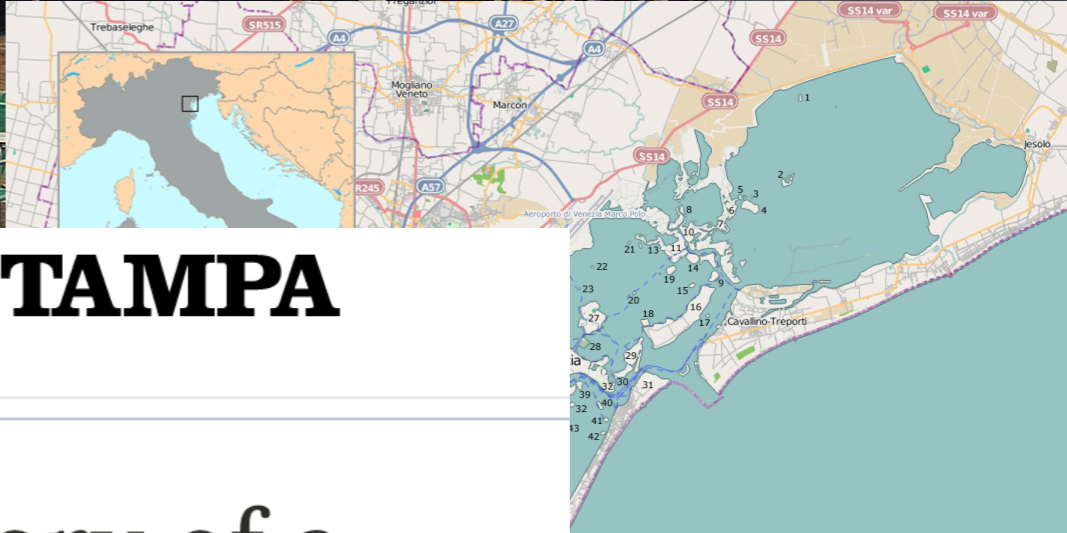
K. Frieler et al.: Delaying future sea-level rise by storing water in Antarctica



“850 000 wind-energy plants of 1.5 MW, running on full capacity”

Figure 1. Bands of ice mass addition in East Antarctica and ice thickness relaxation for the 800 km band. Left panel: surface velocities of the ice flow of the Antarctic ice sheet (blue shading). Grey strips indicate where ice mass was added to East Antarctica in order to delay future sea-level rise in the different simulations. The ice was added in strips of 200 km width for 100 years. The right panels show the ice thickness relaxation after the end of the mass addition to the 800 km band in time steps of 50 years for two representative sections (left panel, red lines) as an anomaly to the equilibrium simulation.

“How do you make God laugh? Tell him your plans.” —Nicci Gerrard



TOP NEWS

ROBERTO GIOVANNINI*

LA STAMPA

12 Ottobre 2017

Venice and MOSE: story of a failure

After scandals and cost overruns, will the flood barrier project be dismantled? Inspections show that many of the gates have been eroded by sea-life. And the hinges are at risk of cracking

\$6.5B

INSELN IN DER LAGUNE VON VENEDIG

1 Cason Montiron	32 La Grazia
2 La Salina	33 La Giudecca
3 Santa Cristina	34 Sacca Fisola
4 Motta di San Lorenzo	35 Sacca San Biagio
5 Motta dei Cunicci	36 Le Trezze
6 La Cura	37 San Giorgio in Alga
7 Sant'Ariano	38 Sant'Angelo della Polvere
8 Monte dell'Oro	39 San Giorgio Maggiore
9 Crevan	40 San Servolo
10 Torcello	41 San Lazzaro degli Armeni
11 Isola dei Laghi	42 Lazzeretto Vecchio
12 Mazzorbetto	43 San Clemente
13 Mazzorbo	44 Sacca Sessola
14 Burano	45 San Spirito
15 San Francesco del Deserto	46 Pellestrina
16 Sant'Erasmo	47 Poveglia
17 Secca del Bacan	48 Poldo
18 Lazzeretto Nuovo	49 Ex Poveglia
19 Madonna del Monte	50 Fislis
20 San Giacomo in Paludo	51 Ottogono abbandonato
21 Buel del Lovo	52 Ottogono degli Alberoni
22 Carbonera	53 Cason Torson di Sotto
23 Tessara	54 Cason Prime Poste
24 Campalto	55 Cason Millecampi
25 San Giuliano	56 Motta di Beverara
26 San Secondo	57 Motta Petta di Bo
27 Murano	58 Motta dell'Aseo
28 San Michele	59 Ottogono di San Pietro
29 Le Vignole	60 Ottogono di San Roman
30 La Certosa	61 Aleghero
31 Il Lido	62 Chioggia

0 2,5 5 km 10

Climate change is true
whether or not you
believe in it.

Since it is true, we
cannot do nothing. We
mitigate, adapt, or lose.

and so castles made of sand,
fall in the sea eventually

—Jimi Hendrix





"Not everything that is faced can be changed, but nothing can be changed until it is faced." - James Baldwin

Fridays for Future



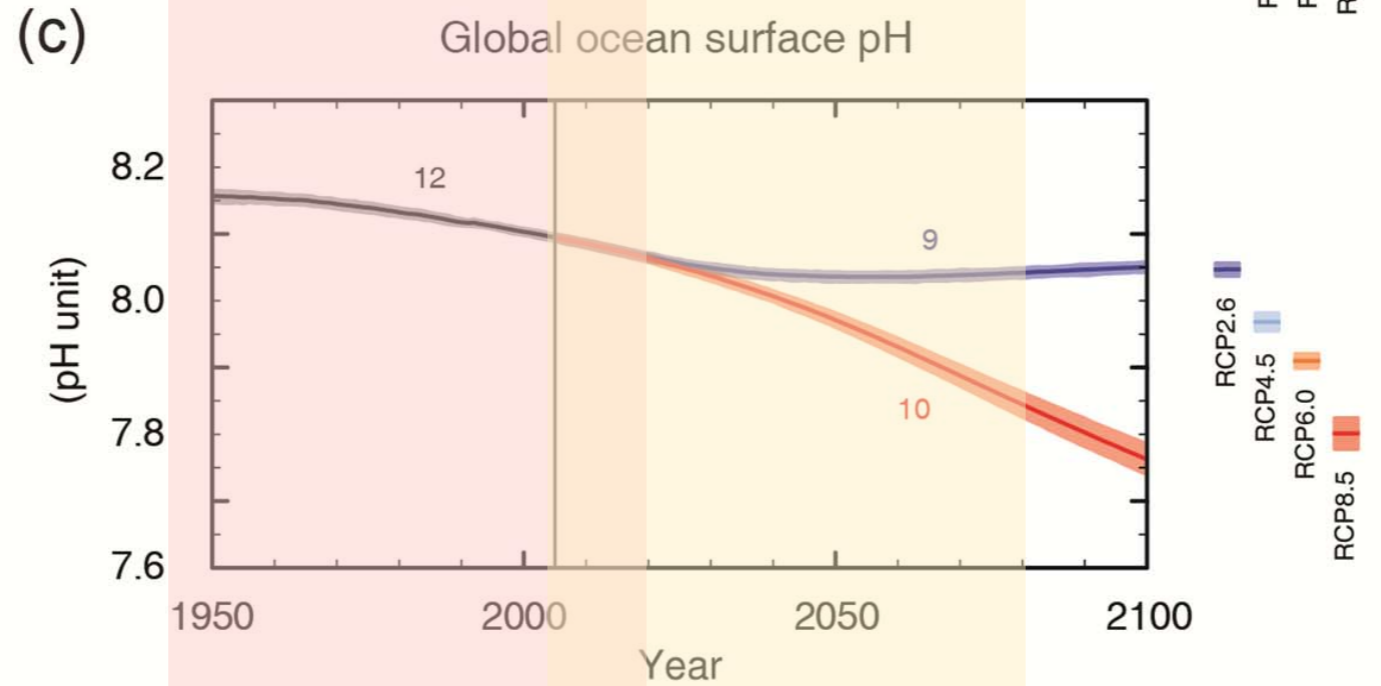
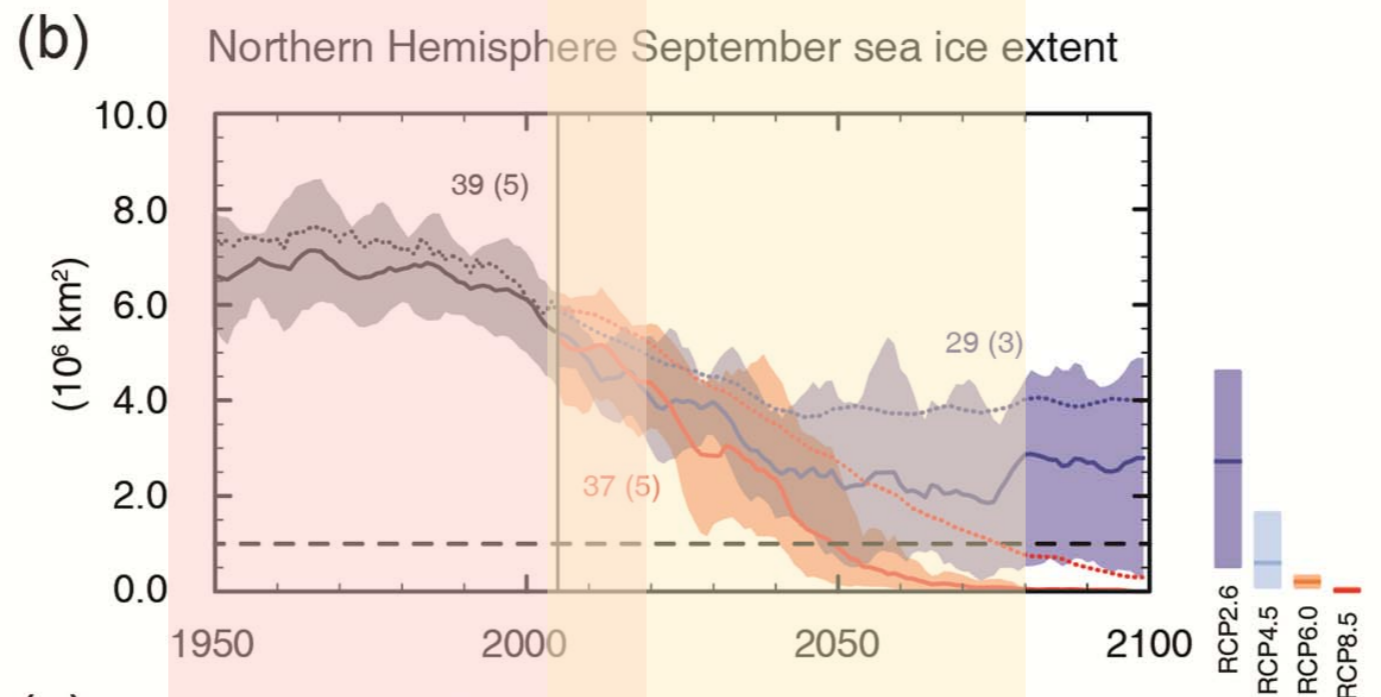
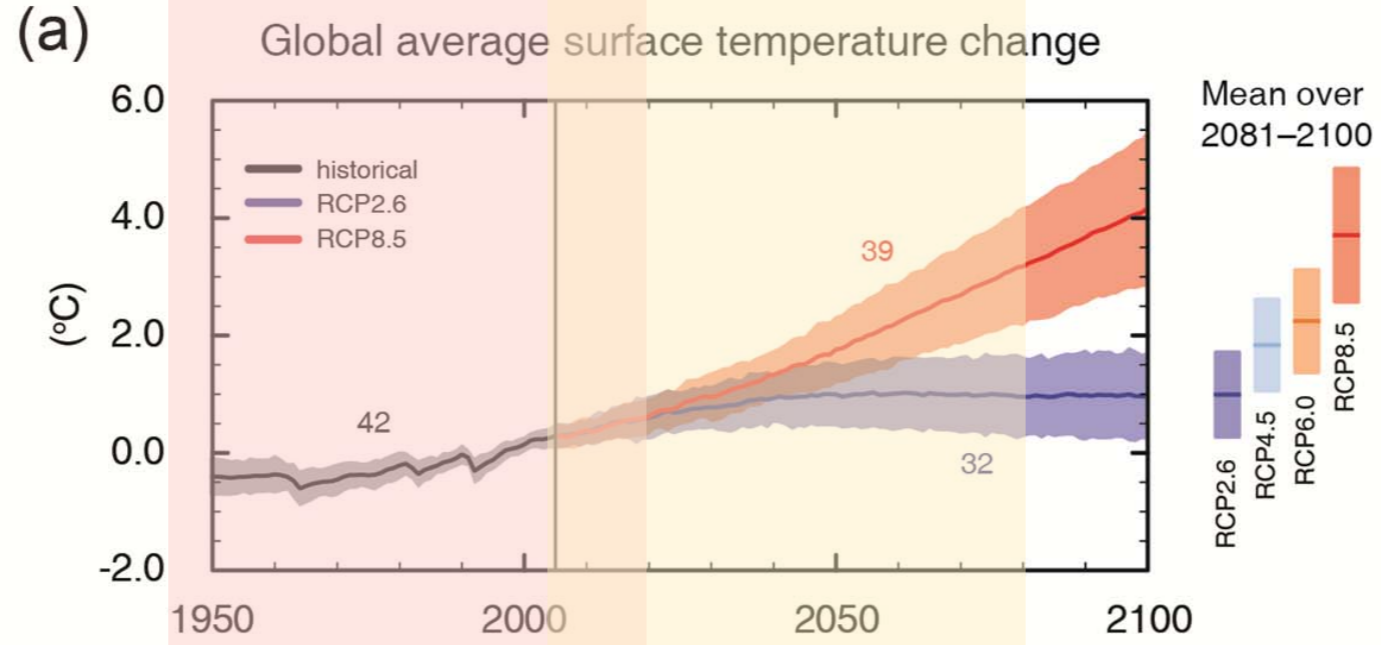
SKOLSTREJK
FÖR
KLIMATET



Future Projections



floridapolitics.com



IPCC
AR5
(2013)

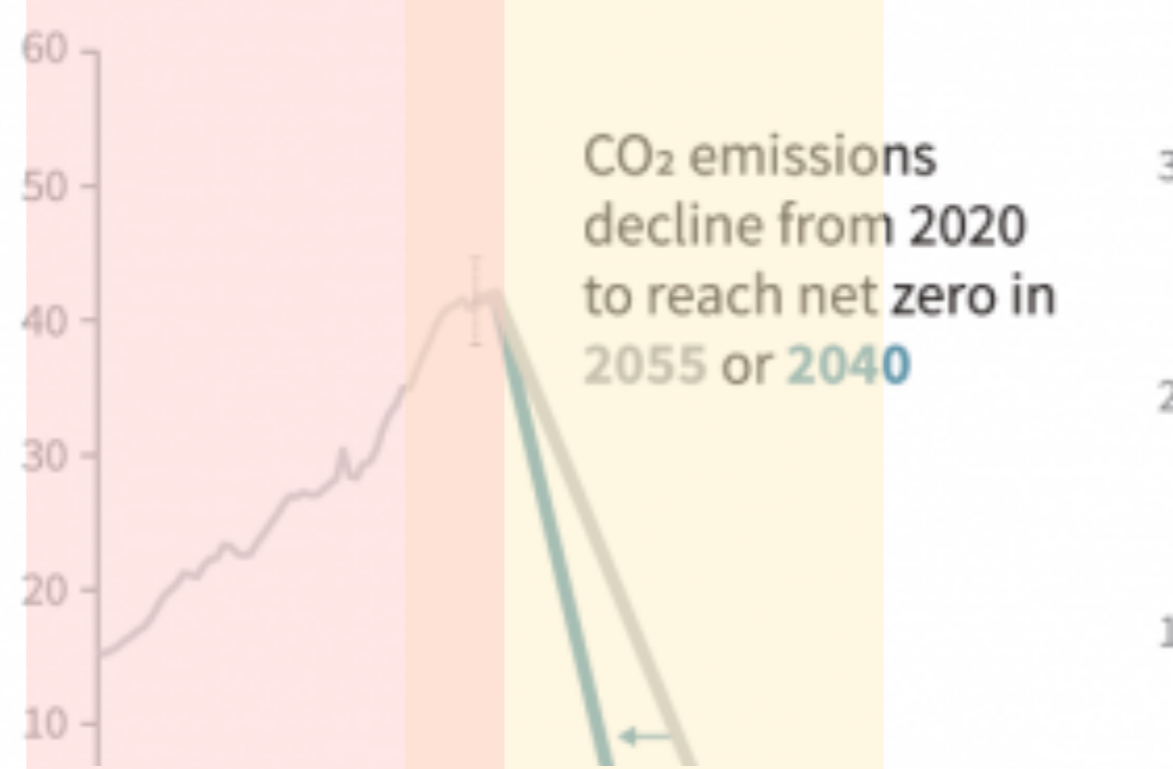
To Stay
Below
+2C



floridapolitics.com

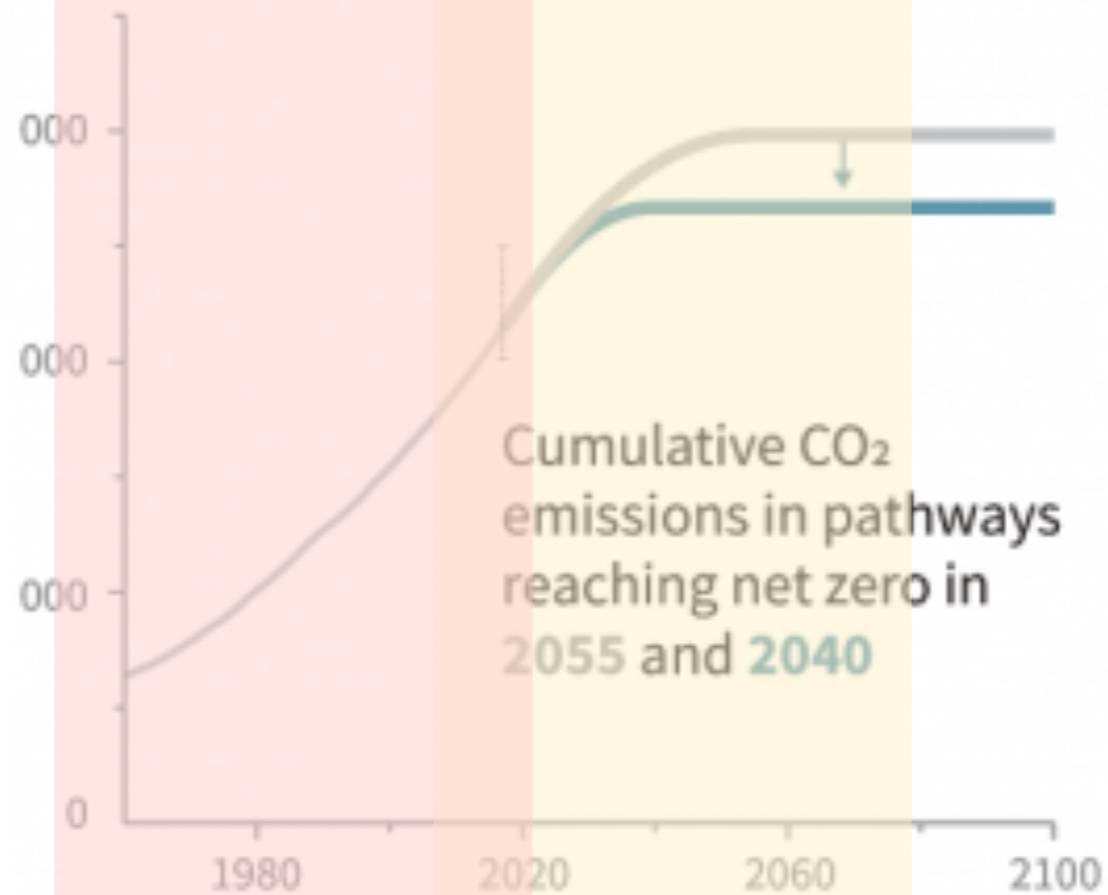
b) Stylized net global CO₂ emission pathways

Billion tonnes CO₂ per year (GtCO₂/yr)



c) Cumulative net CO₂ emissions

Billion tonnes CO₂ (GtCO₂)



IPCC
SR1.5
(2018)

"How Dare You?"

"This is all wrong, I shouldn't be up here."

"You have stolen my dreams and my childhood with your empty words. [...]

We are at the beginning of a mass extinction and all you can talk about is money and fairy tales of endless economic growth."



Noting the arrival of Pres. Trump at the Summit

"For more than 30 years, the science has been crystal clear. How dare you continue to look away?"

-Greta Thunberg

Speaking at the
UN Global Climate Action Summit

What can Brown do?

• Set a good example:

- Divest from fossil fuels. Invest in renewables.
- Sustainability Initiatives
 - Zero net campus emissions (total: electricity & heating) by 2030
 - Go beyond zero on campus: carbon offset for academic travel, RI, etc.
- Brown's direct impact is small, but people will act when we lead

• Hire

- Earth Scientists (e.g., employed in struggling federal & state agencies)
- Env. Policy, Env. Social Sciences, Env. Engineering

• Study

- Science Basis & Quantify Impacts
- Mitigation & Adaptation Technologies
- Env. Policy & Social Sciences
 - motivate change, effective policy not empty gestures
- Env. Humanities—Castles Made of Sand, Climate Anxiety, Rise

• Stay Productive & Focused

- Health, Family, Community, Coping with Stress & Anger
- It's a marathon, not a sprint



Prof. Katharine Hayhoe  @KHayhoe · 4h

Climate Change:

It's real.

It's us.

It's serious - and becoming dangerous.

But there are solutions, and there is hope.

The science is clear: the faster we reduce our emissions, the less impacts there will be.

[#ClimateStrike](#)