Decarbonized or Destitute?

Dr. Brett Favaro
@LetsFishSmarter
April 23, 2020

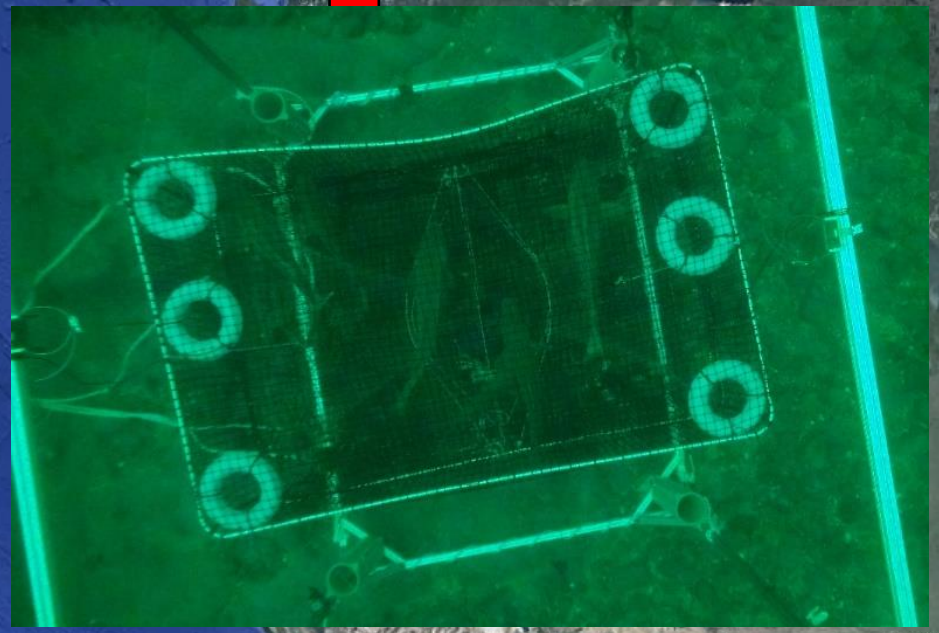
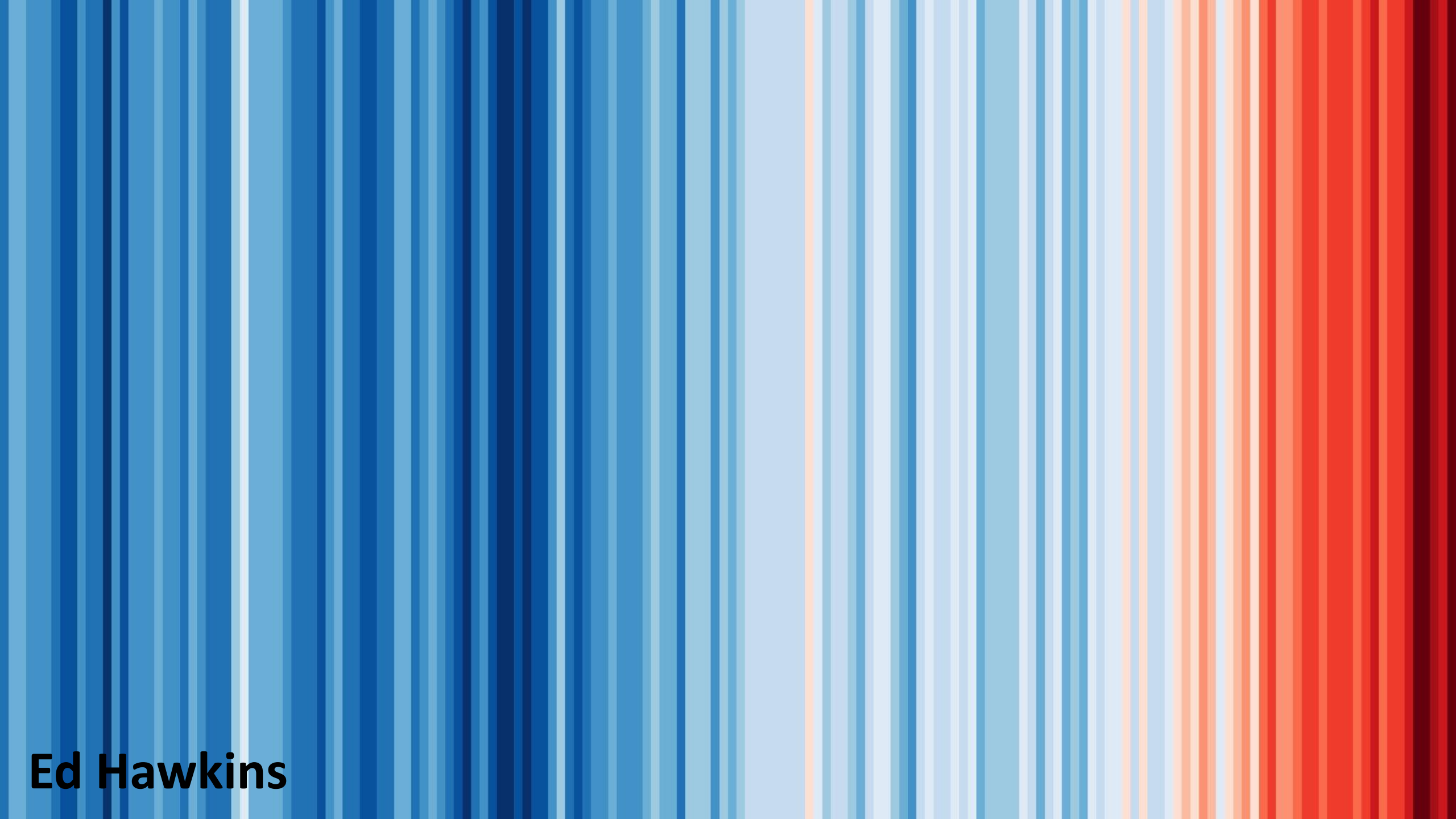
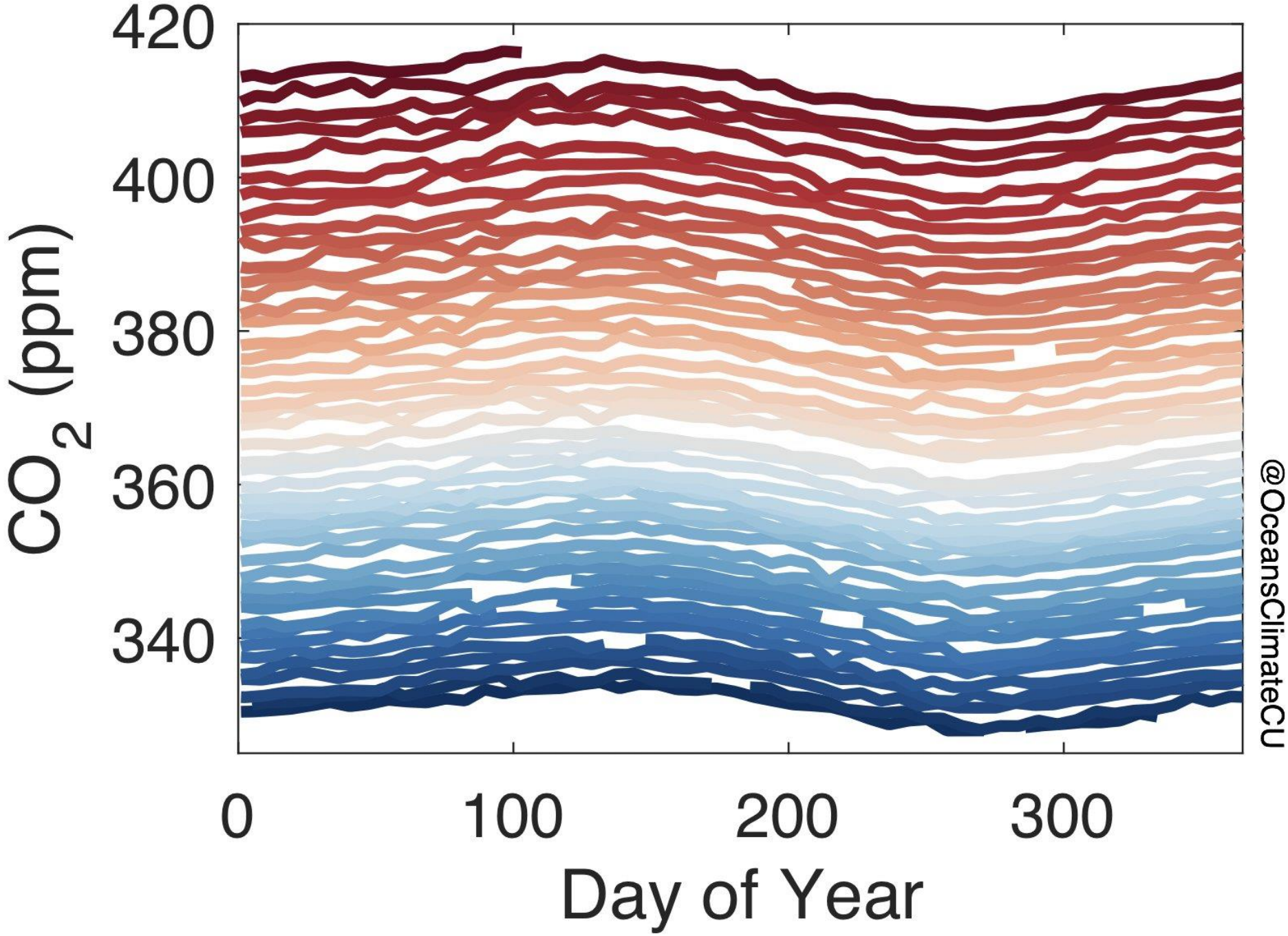


Image I
Image U.S. Geo
Image L
Data SIO, NOAA, U.S.

Tour Guide

74°00'19.43" N 113°26'32.54" W elev -2 ft eye alt 3589.78 mi


Ed Hawkins

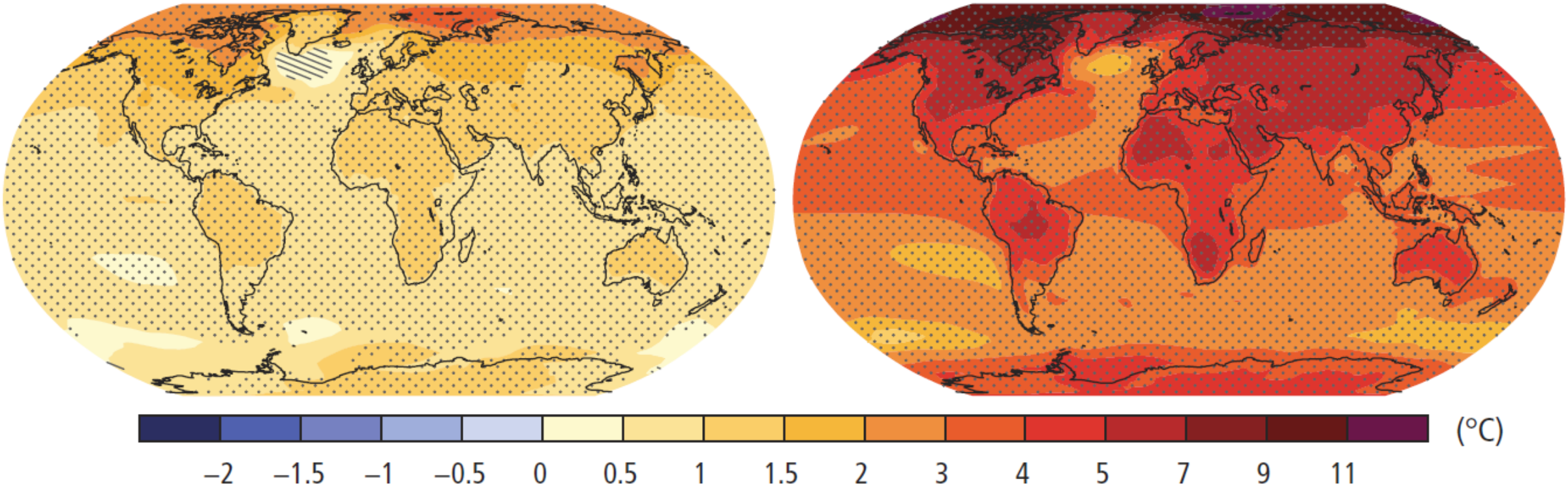

420
400
380
360
340
CO_2 (ppm)
0
100
200
300
Day of Year
@OceansClimateCU

Please tweet today's talk

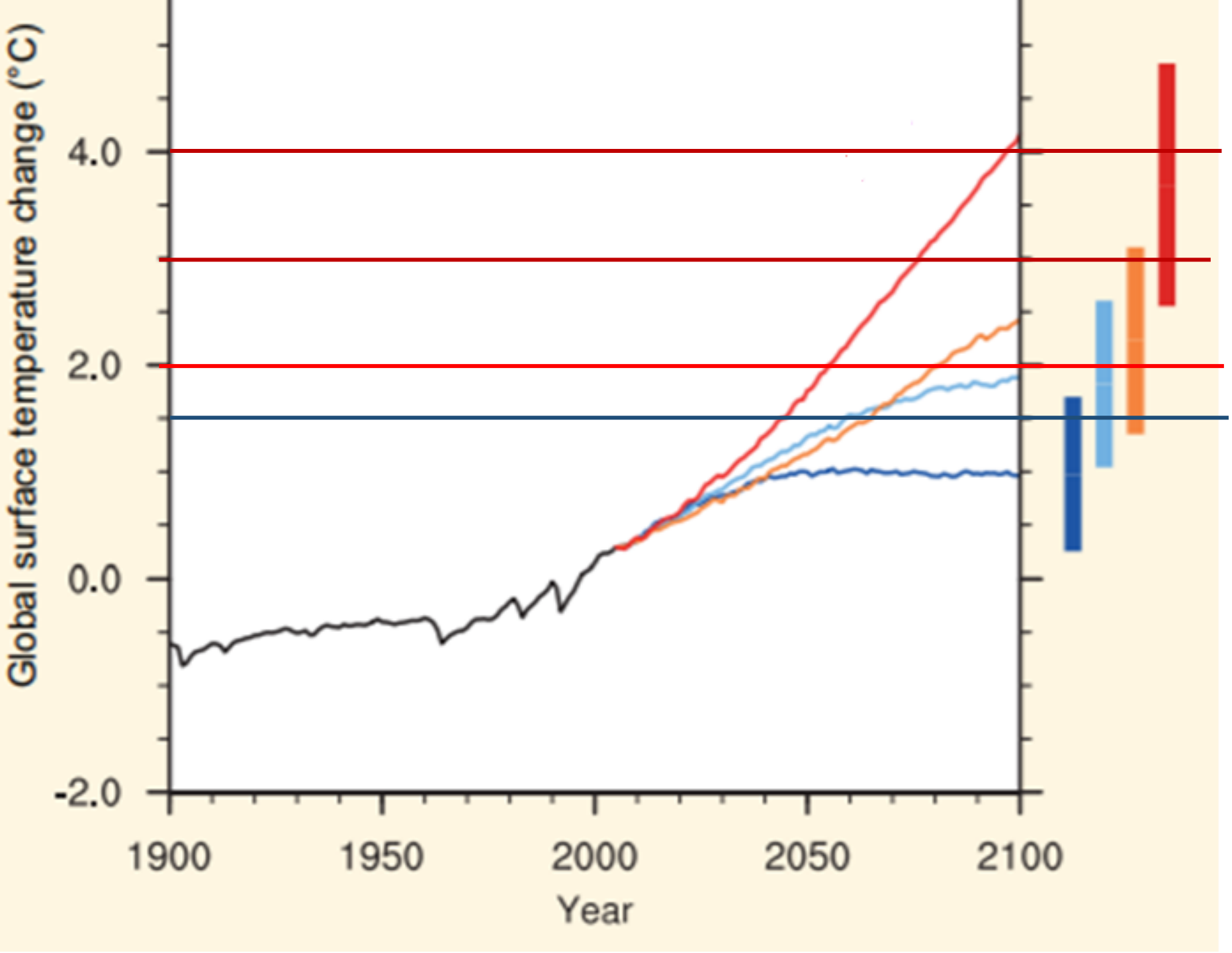
#ImagineThePotential

#MyOffshoreMyFuture

Part 1: The Planet



*"a 4 degrees C future is **incompatible with an organized global community**, is likely to be beyond 'adaptation', is devastating to the majority of ecosystems, and has a high probability of not being stable."* - Professor Kevin Anderson. Tyndall Centre for Climate Change Research



4° (Upper estimate, B.A.U.)

3° (B.A.U.)

2° limit

1.5° safest limit

Climate change is ocean change

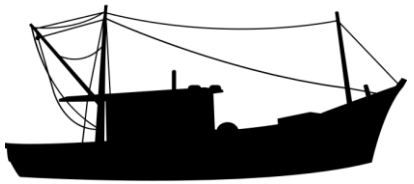
Rise

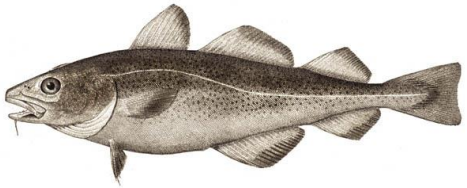
Heating

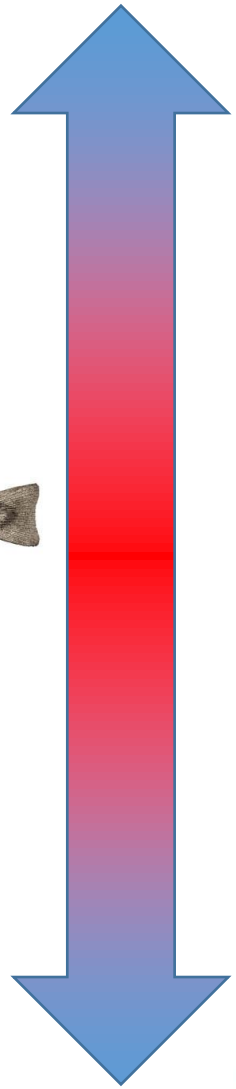
Acidification

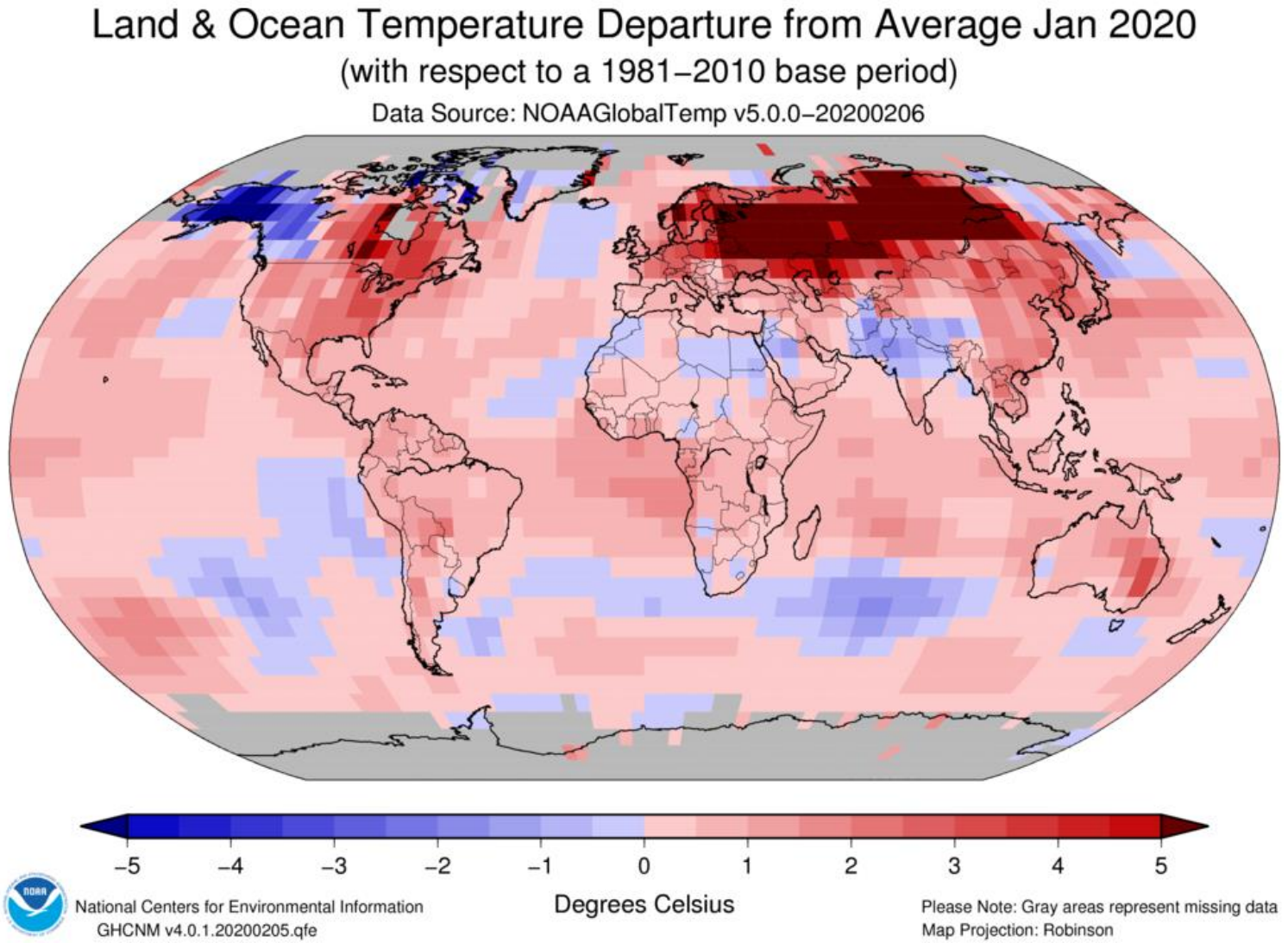
Deoxygenation

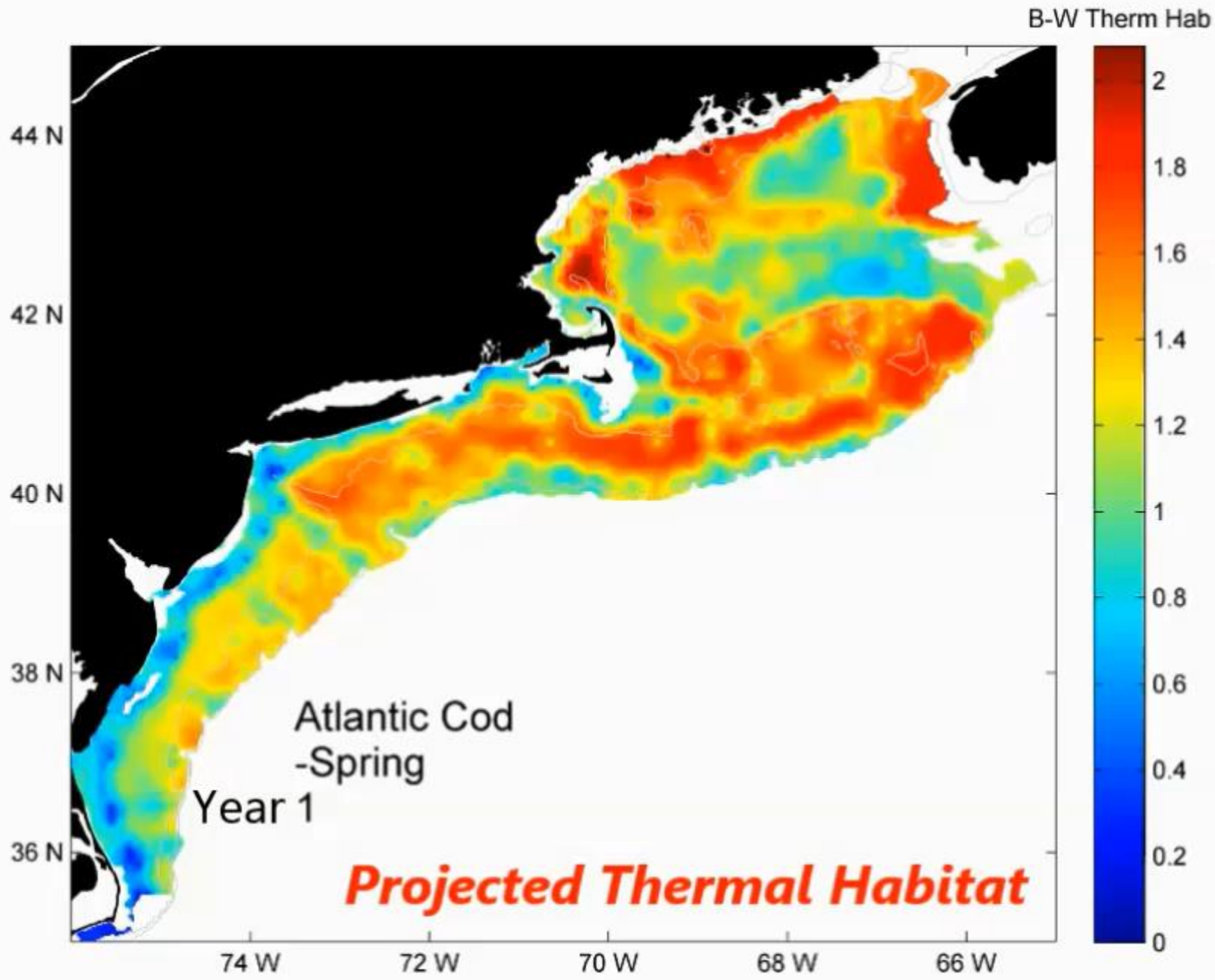
Climate change is ocean change: HEATING











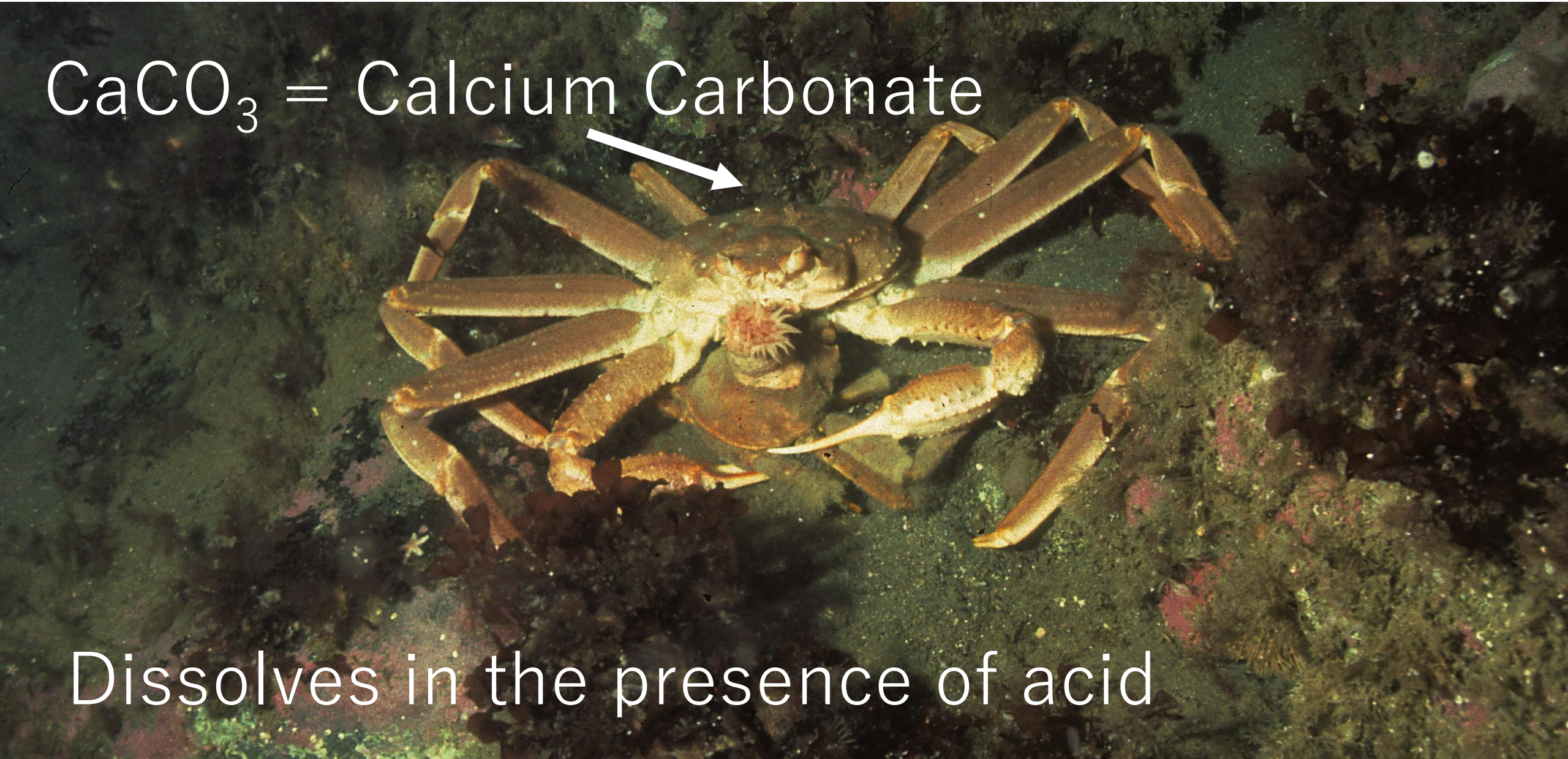
https://www.nefsc.noaa.gov/ecosys/climate-change/projected-thermal-habitat/atlantic-cod.html

Climate change is ocean change: ACIDIFICATION

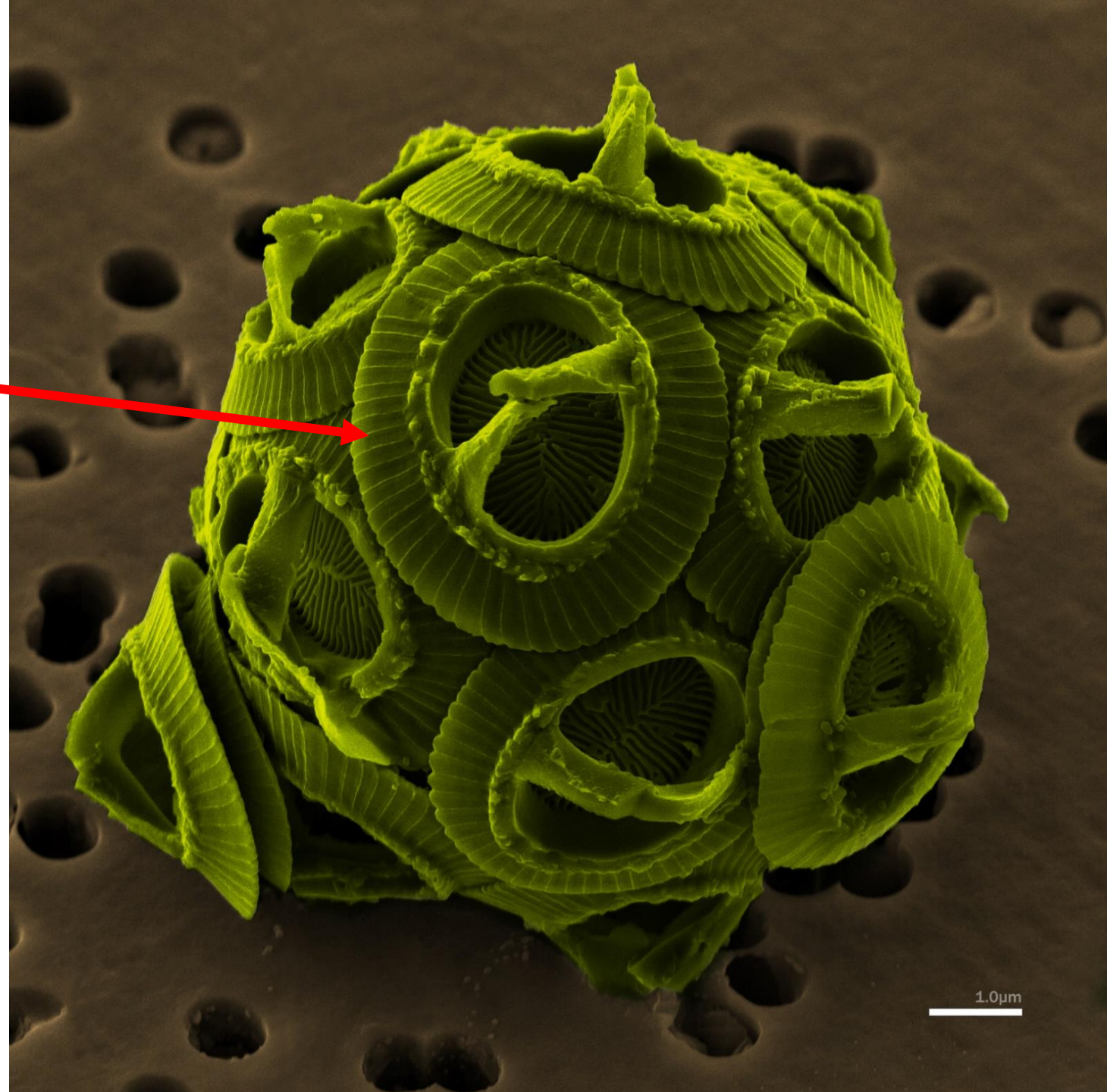
$CO_2 + H_2O \leftrightarrow$ Carbonic Acid: $H_2CO_3^-$

Increase in CO_2 pushes equilibrium to the right

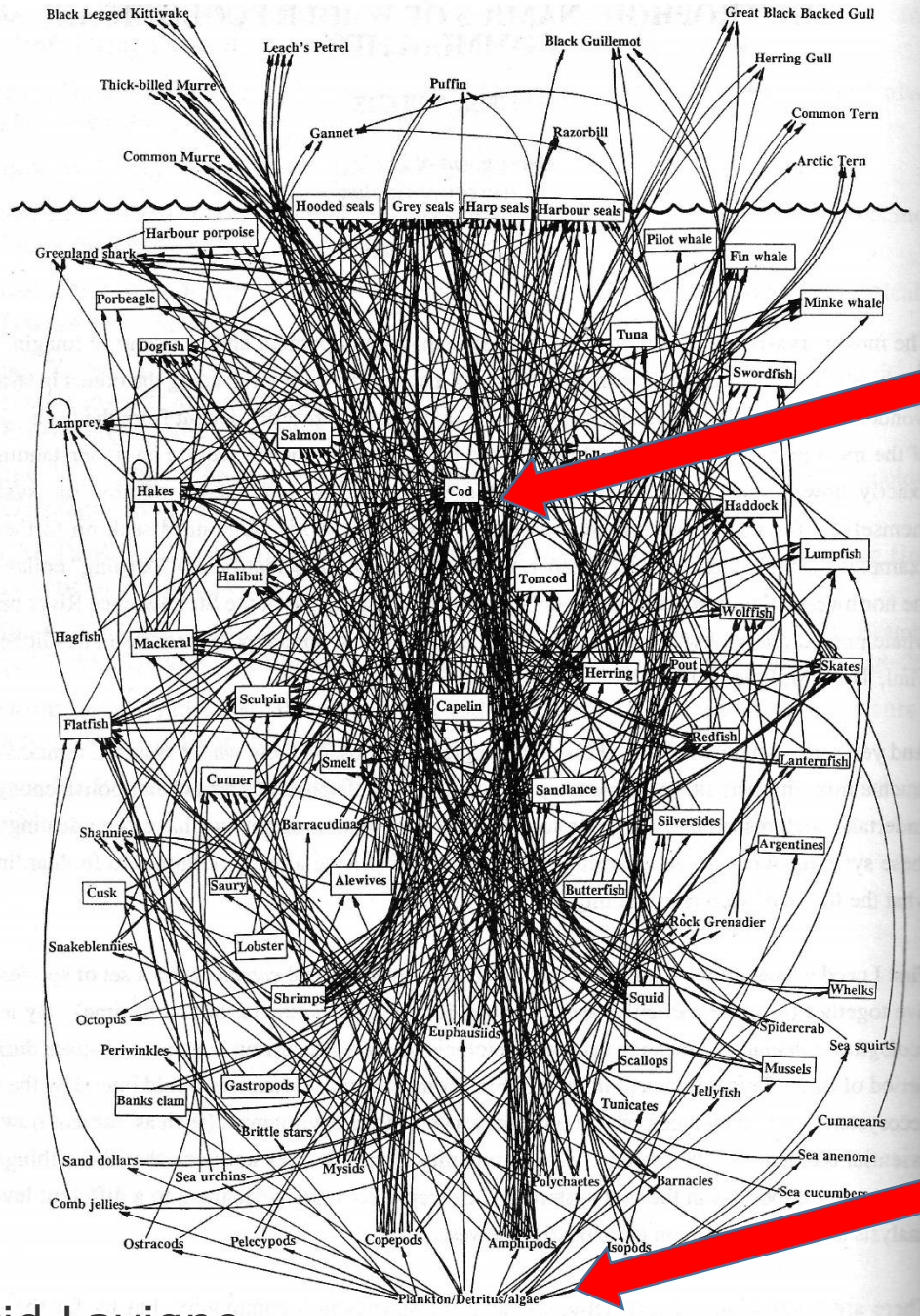
Climate change is ocean change: ACIDIFICATION

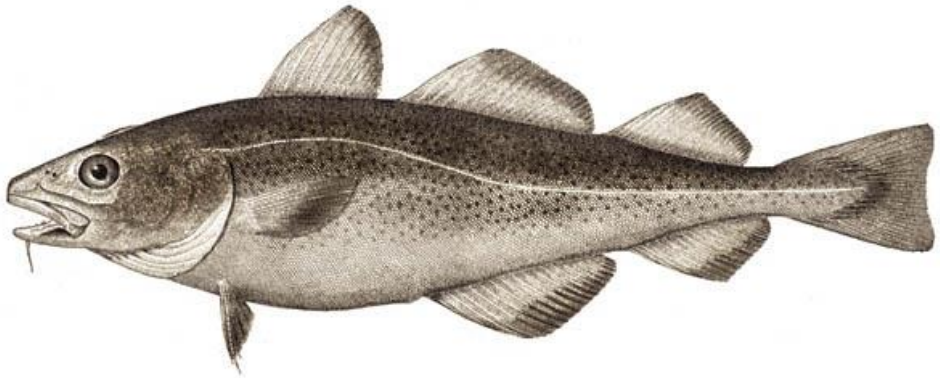


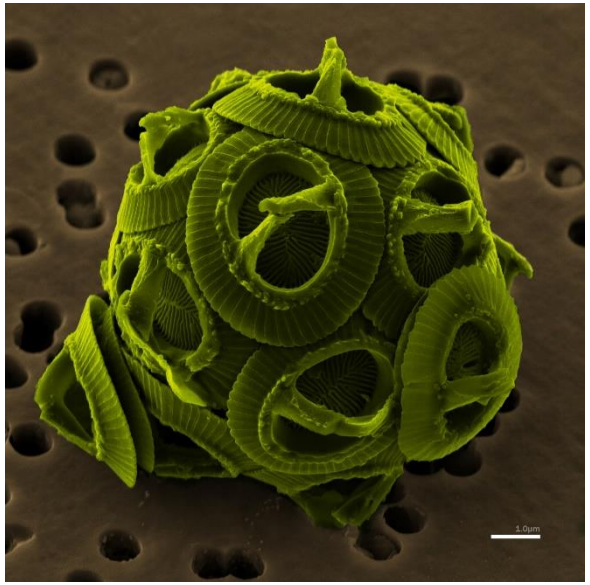
$CaCO_3$ Calcium Carbonate



Riebesell et al (2000) - Nature



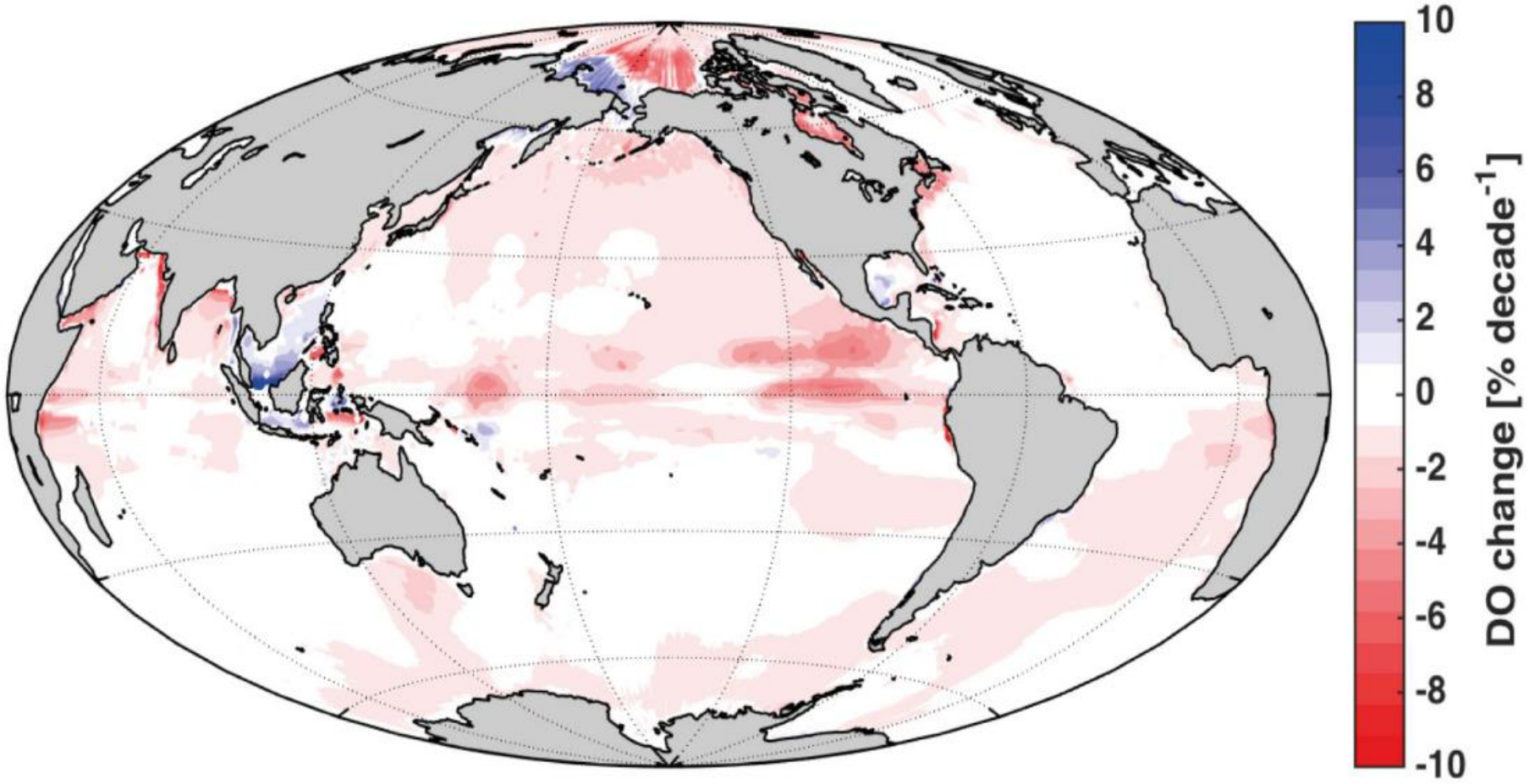




David Lavigne

Climate change is ocean change: DEOXYGENATION

In 50 years, the world's oceans have already lost 2% of their oxygen



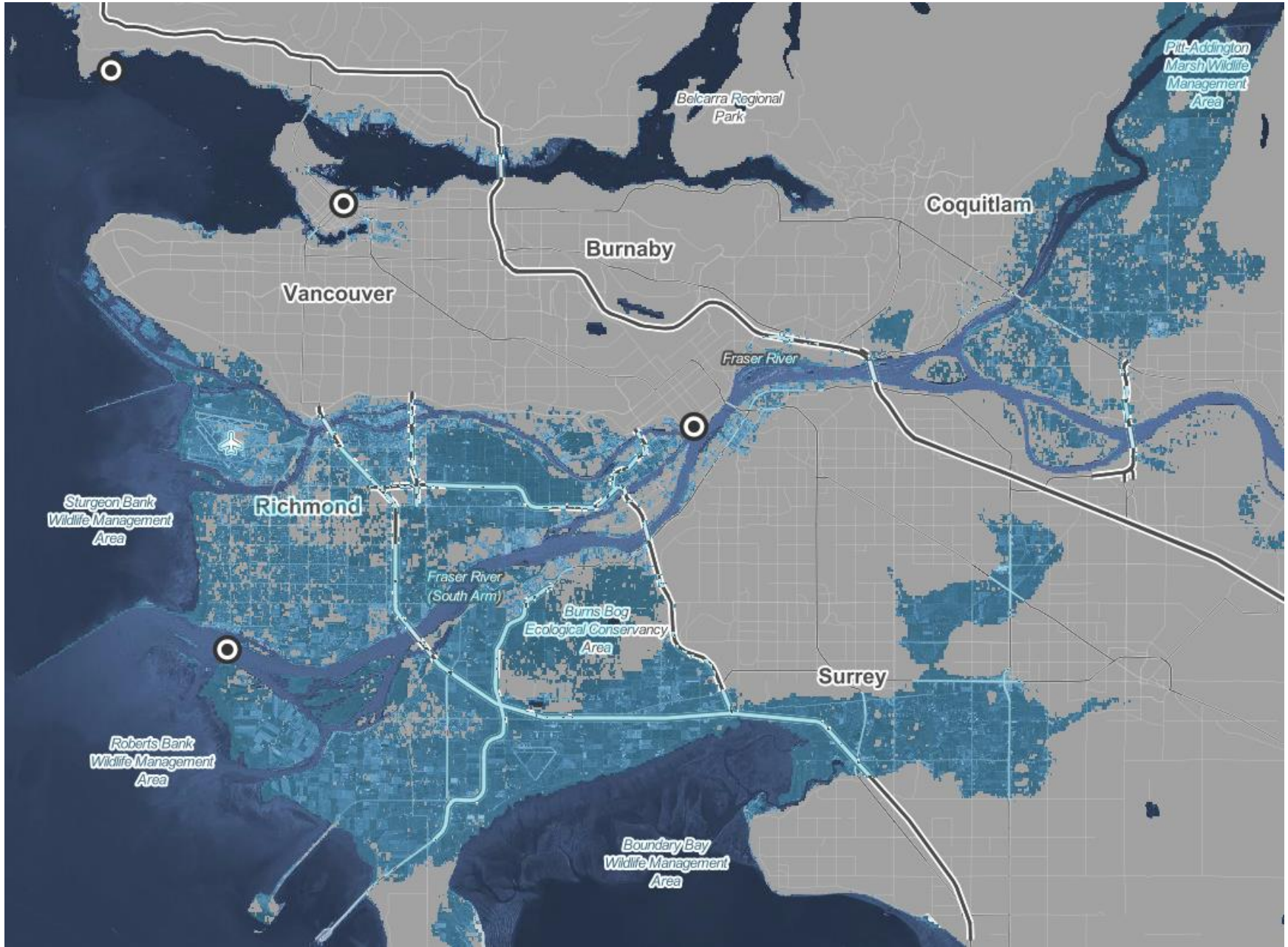
By 2100: It will be 7%

Schmidtko et al. (2017)

Climate change is fisheries change: RISE

Sea level rise: 2 m

Vancouver, BC: 2 m



ENVIRONMENT

Greenland's ice sheet melts by record amount due to climate change, study shows

PUBLISHED WED, APR 15 2020•2:58 PM EDT | UPDATED WED, APR 15 2020•3:07 PM EDT

Emma Newburger
@EMMA_NEWBURGER

- If Greenland's ice sheet were to melt away completely, global sea levels could rise by as much as 23 feet.

Article

The projected timing of abrupt ecological disruption from climate change

https://doi.org/10.1038/s41586-020-2189-9

Christopher H. Trisos[1,2,3], Cory Merow[4] & Alex L. Pigot[5]✉

When they examined the projections, the researchers were surprised that sudden collapses appeared across almost all species — fish, reptiles, amphibians, birds and mammals — and across almost all regions.

“It’s not that it happens in some places,” said Cory Merow, an ecologist at the University of Connecticut and one of the study’s authors. “No matter how you slice the analysis, it always seems to happen.”

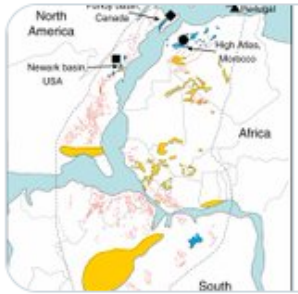
The Permian Extinction: 95% of life on earth lost 252 million years ago

[we] conclude that increased marine temperatures and reduced oxygen availability were responsible for a majority of the recorded extinctions. Because similar environmental alterations are predicted outcomes of current climate change, we would be wise to take note.

Penn et al. (2018)

Nature Communications
@NatureComms

The volumes of CO2 released during end-Triassic volcanic eruption pulses were likely comparable to the amount of anthropogenic 21st Century CO2 emissions



Deep CO 2 in the end-Triassic Central Atlantic Magmatic Provi...
Many major mass extinction events have been associated with large volcanic eruption events, with the argument that large ...
nature.com

Peter Brannen
@PeterBrannen1

The end-Triassic mass extinction wiped out coral reefs for hundreds of thousands of years and killed up to 80% of all species on earth

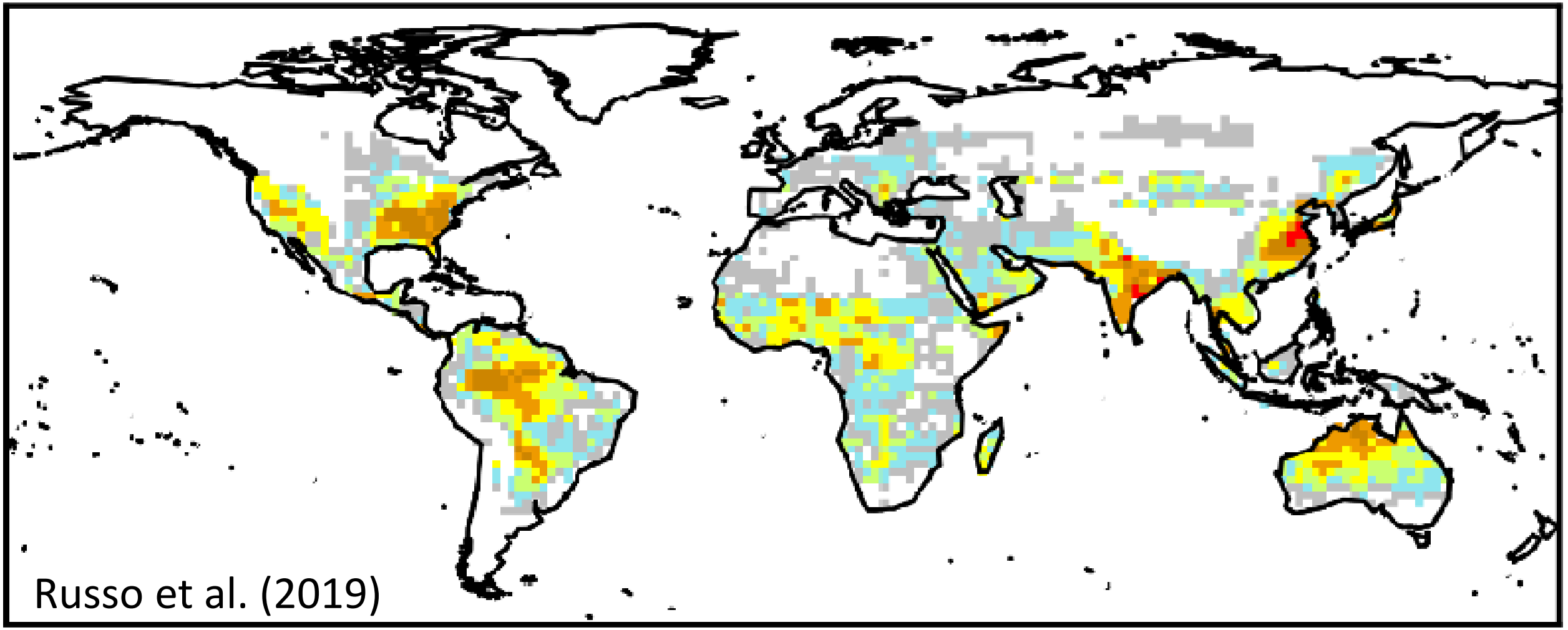
Part 2: The People

Climate change is geopolitical change

Climate change is agriculture change

Climate change is economic change

Climate change is geopolitical change

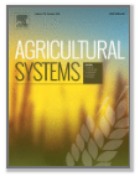


Under RCP 8.5, by 2100 ~500 million people will live in places that experience humid heat waves that can kill a healthy person in 6 hours, even in the shade

Climate change is agriculture change

ELSEVIER

Agricultural Systems
Volume 175, October 2019, Pages 34-45

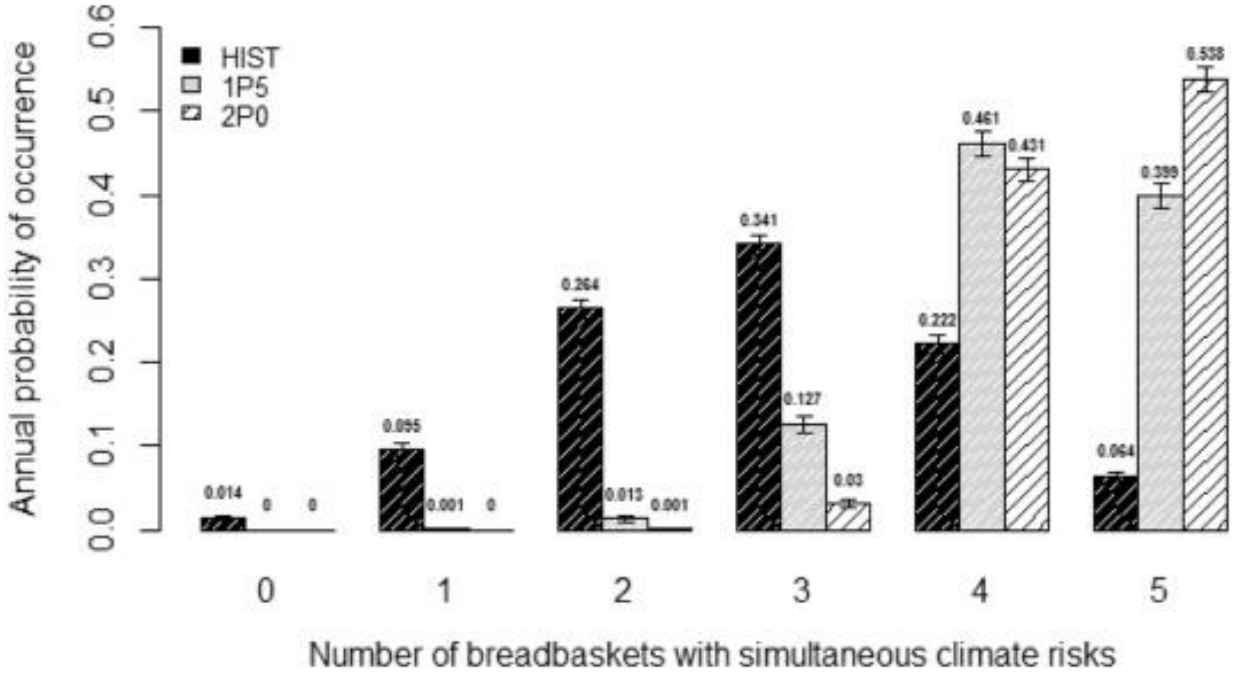


Increasing risks of multiple breadbasket failure under 1.5 and 2 °C global warming

Franziska Gaupp [a, b], Jim Hall [a], Dann Mitchell [c], Simon Dadson [d]

Show more

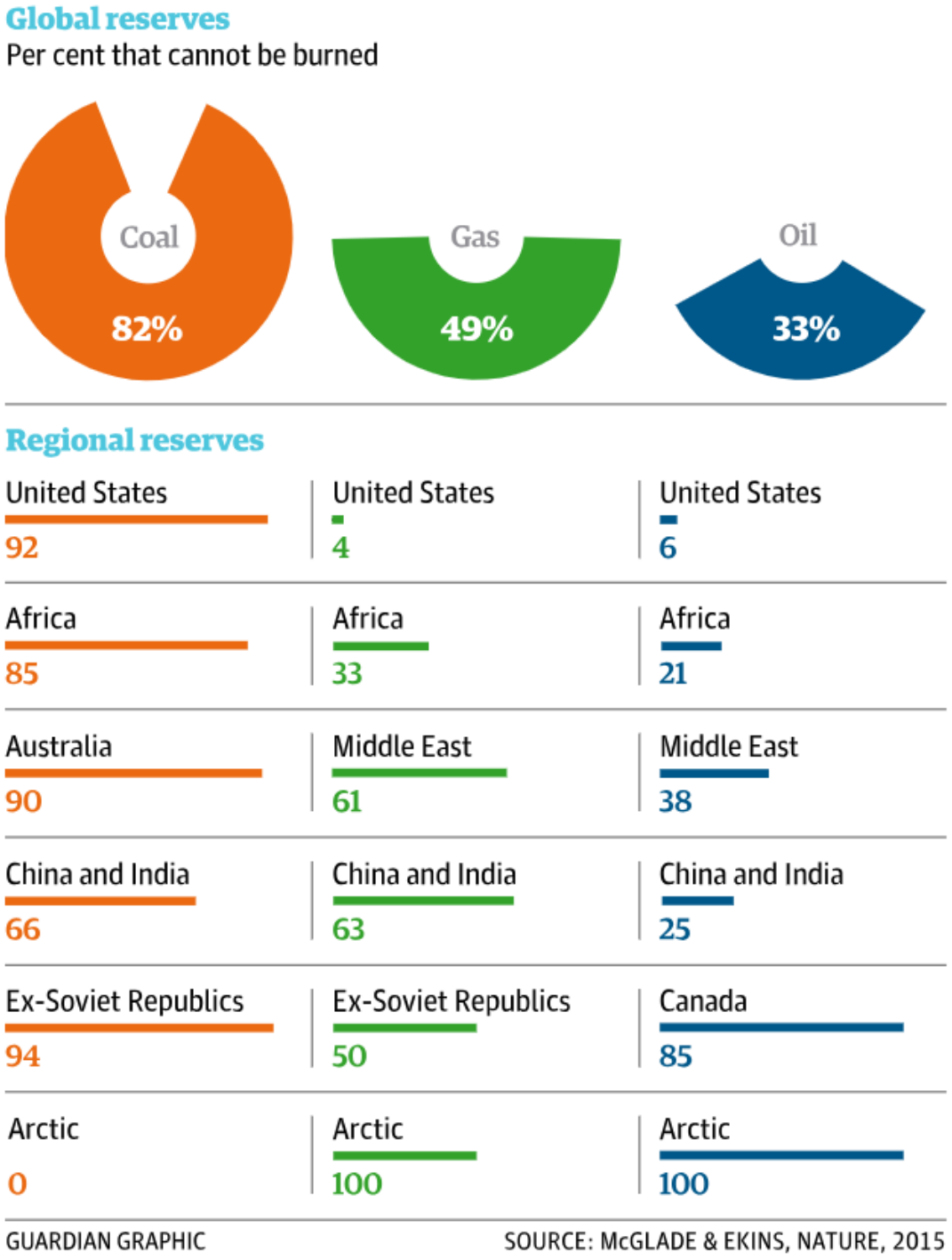
https://doi.org/10.1016/j.agsy.2019.05.010



"Projected wheat, maize and soybean yield losses in the global breadbaskets increase disproportionately between 1.5 and 2 °C global warming."

Climate change is economic change

To stay below 2 degrees C, 85% of Canadian oil reserves cannot be burned
(McGlade and Ekins, 2015)



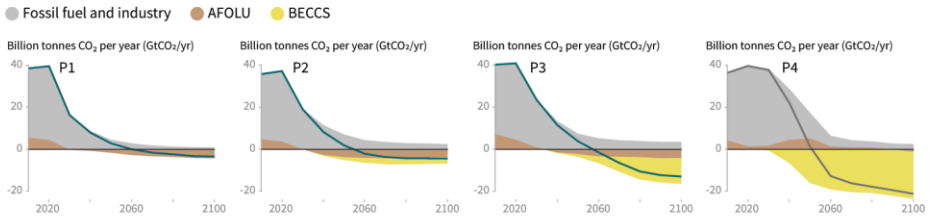
So what do we do?

https://www.ipcc.ch/sr15/

Characteristics of four illustrative model pathways

Different mitigation strategies can achieve the net emissions reductions that would be required to follow a pathway that limits global warming to 1.5°C with no or limited overshoot. All pathways use Carbon Dioxide Removal (CDR), but the amount varies across pathways, as do the relative contributions of Bioenergy with Carbon Capture and Storage (BECCS) and removals in the Agriculture, Forestry and Other Land Use (AFOLU) sector. This has implications for emissions and several other pathway characteristics.

Breakdown of contributions to global net CO_2 emissions in four illustrative model pathways



P1: A scenario in which social, business and technological innovations result in lower energy demand up to 2050 while living standards rise, especially in the global South. A downsized energy system enables rapid decarbonization of energy supply. Afforestation is the only CDR option considered; neither fossil fuels with CCS nor BECCS are used.

P2: A scenario with a broad focus on sustainability including energy intensity, human development, economic convergence and international cooperation, as well as shifts towards sustainable and healthy consumption patterns, low-carbon technology innovation, and well-managed land systems with limited societal acceptability for BECCS.

P3: A middle-of-the-road scenario in which societal as well as technological development follows historical patterns. Emissions reductions are mainly achieved by changing the way in which energy and products are produced, and to a lesser degree by reductions in demand.

P4: A resource- and energy-intensive scenario in which economic growth and globalization lead to widespread adoption of greenhouse-gas-intensive lifestyles, including high demand for transportation fuels and livestock products. Emissions reductions are mainly achieved through technological means, making strong use of CDR through the deployment of BECCS.

Global indicators	P1	P2	P3	P4	**Interquartile range**
Pathway classification	No or limited overshoot	o or limited overshoot	No or limited overshoot	Higher overshoot	No or limited overshoot
CO_2 emission change in 2030 (% rel to 2010)	-58	-47	-41	4	(-58,-40)
└ in 2050 (% rel to 2010)	-93	-95	-91	-97	(-107,-94)
Kyoto-GHG emissions in 2030 (% rel to 2010)*	-50	-49	-35	-2	(-51,-39)
└ in 2050 (% rel to 2010)	-82	-89	-78	-80	(-93,-81)
*Final energy demand** in 2030 (% rel to 2010)*	-15	-5	17	39	(-12,7)
└ in 2050 (% rel to 2010)	-32	2	21	44	(-11,22)
Renewable share in electricity in 2030 (%)	60	58	48	25	(47,65)
└ in 2050 (%)	77	81	63	70	(69,86)
Primary energy from coal in 2030 (% rel to 2010)	-78	-61	-75	-59	(-78, -59)
└ in 2050 (% rel to 2010)	-97	-77	-73	-97	(-95, -74)
from oil in 2030 (% rel to 2010)	-37	-13	-3	86	(-34,3)
└ in 2050 (% rel to 2010)	-87	-50	-81	-32	(-78,-31)
from gas in 2030 (% rel to 2010)	-25	-20	33	37	(-26,21)
└ in 2050 (% rel to 2010)	-74	-53	21	-48	(-56,6)
from nuclear in 2030 (% rel to 2010)	59	83	98	106	(44,102)
└ in 2050 (% rel to 2010)	150	98	501	468	(91,190)
from biomass in 2030 (% rel to 2010)	-11	0	36	-1	(29,80)
└ in 2050 (% rel to 2010)	-16	49	121	418	(123,261)
from non-biomass renewables in 2030 (% rel to 2010)	430	470	315	110	(245,436)
└ in 2050 (% rel to 2010)	833	1327	878	1137	(576,1299)
Cumulative CCS until 2100 ($GtCO_2$)	0	348	687	1218	(550,1017)
└ of which BECCS ($GtCO_2$)	0	151	414	1191	(364,662)
Land area of bioenergy crops in 2050 (million km^2)	0.2	0.9	2.8	7.2	(1.5,3.2)
Agricultural CH_4 emissions in 2030 (% rel to 2010)	-24	-48	1	14	(-30,-11)
in 2050 (% rel to 2010)	-33	-69	-23	2	(-47,-24)
Agricultural N_2O emissions in 2030 (% rel to 2010)	5	-26	15	3	(-21,3)
in 2050 (% rel to 2010)	6	-26	0	39	(-26,1)

NOTE: Indicators have been selected to show global trends identified by the Chapter 2 assessment. National and sectoral characteristics can differ substantially from the global trends shown above.

** Kyoto-gas emissions are based on IPCC Second Assessment Report GWP-100*
*** Changes in energy demand are associated with improvements in energy efficiency and behaviour change*

Global indicators	P1
Pathway classification	No or limited overshoot
CO_2 emission change in 2030 (% rel to 2010)	-58
↳ in 2050 (% rel to 2010)	-93
Kyoto-GHG emissions in 2030 (% rel to 2010)*	-50
↳ in 2050 (% rel to 2010)	-82
*Final energy demand** in 2030 (% rel to 2010)*	-15
↳ in 2050 (% rel to 2010)	-32
Renewable share in electricity in 2030 (%)	60
↳ in 2050 (%)	77
Primary energy from coal in 2030 (% rel to 2010)	-78
↳ in 2050 (% rel to 2010)	-97
from oil in 2030 (% rel to 2010)	-37
↳ in 2050 (% rel to 2010)	-87
from gas in 2030 (% rel to 2010)	-25
↳ in 2050 (% rel to 2010)	-74
from nuclear in 2030 (% rel to 2010)	59
↳ in 2050 (% rel to 2010)	150
from biomass in 2030 (% rel to 2010)	-11
↳ in 2050 (% rel to 2010)	-16
from non-biomass renewables in 2030 (% rel to 2010)	430
↳ in 2050 (% rel to 2010)	833
Cumulative CCS until 2100 ($GtCO_2$)	0
↳ of which BECCS ($GtCO_2$)	0
Land area of bioenergy crops in 2050 (million km^2)	0.2
Agricultural CH_4 emissions in 2030 (% rel to 2010)	-24
in 2050 (% rel to 2010)	-33
Agricultural N_2O emissions in 2030 (% rel to 2010)	5
in 2050 (% rel to 2010)	6

Energy from coal down: **78%** by 2030, **97%** by 2050

… oil down: **37%** by 2030, **87%** by 2050

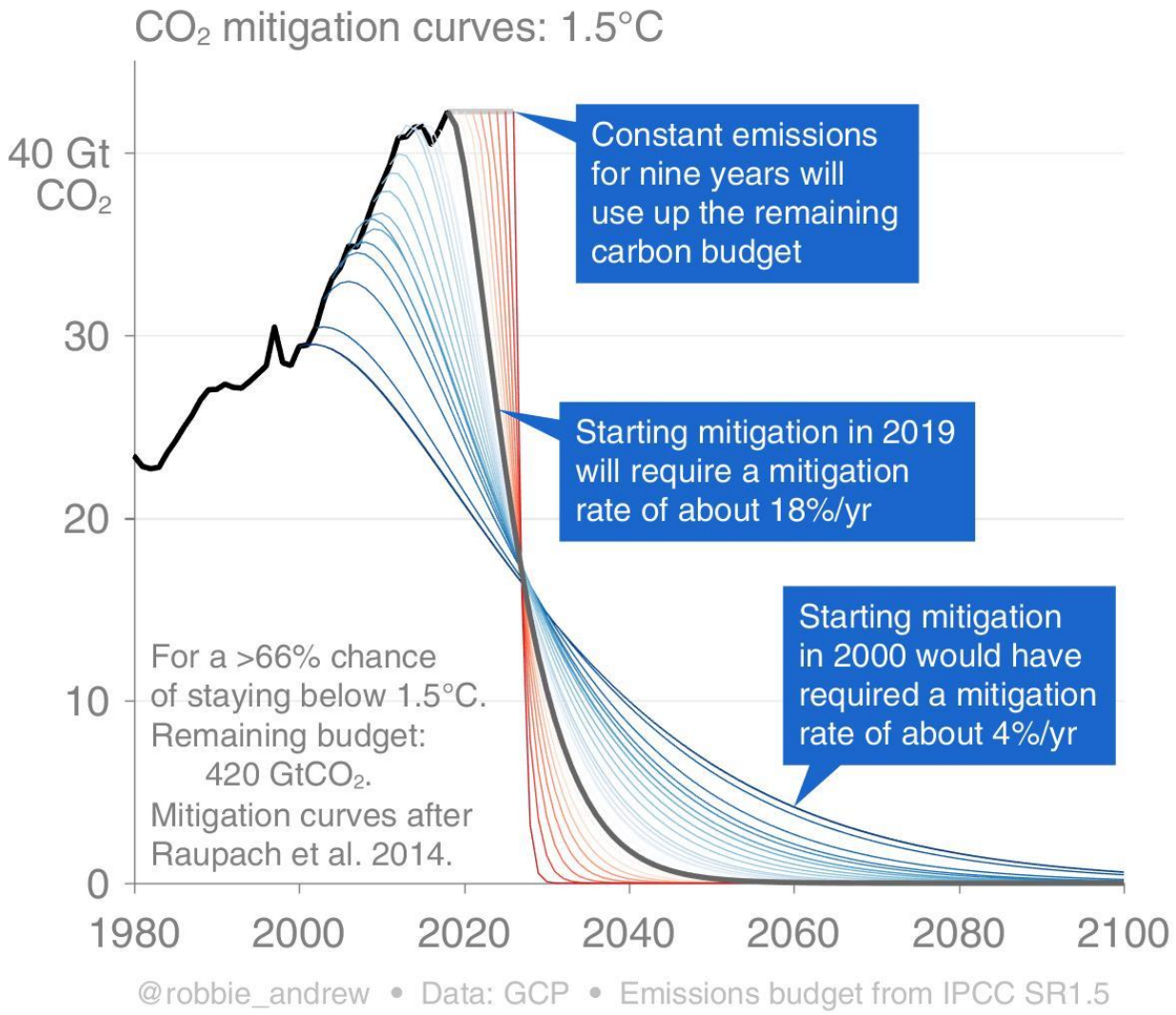
… gas down: **25%** by 2030, **75%** by 2050

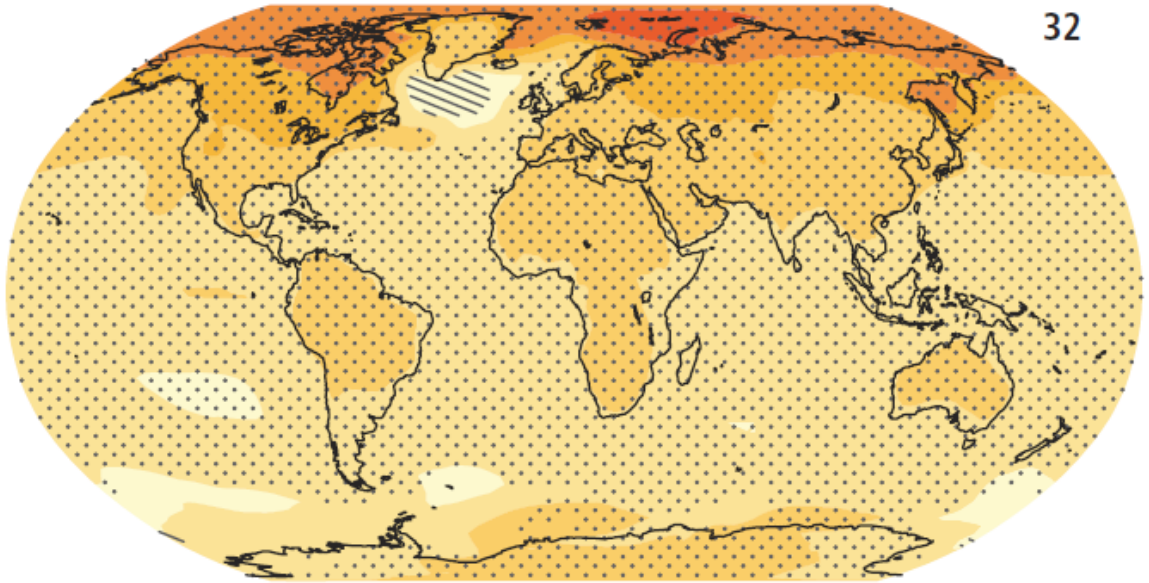
Energy from renewables **UP**

430% by 2030

833% by 2050

The pace of change is unprecedented

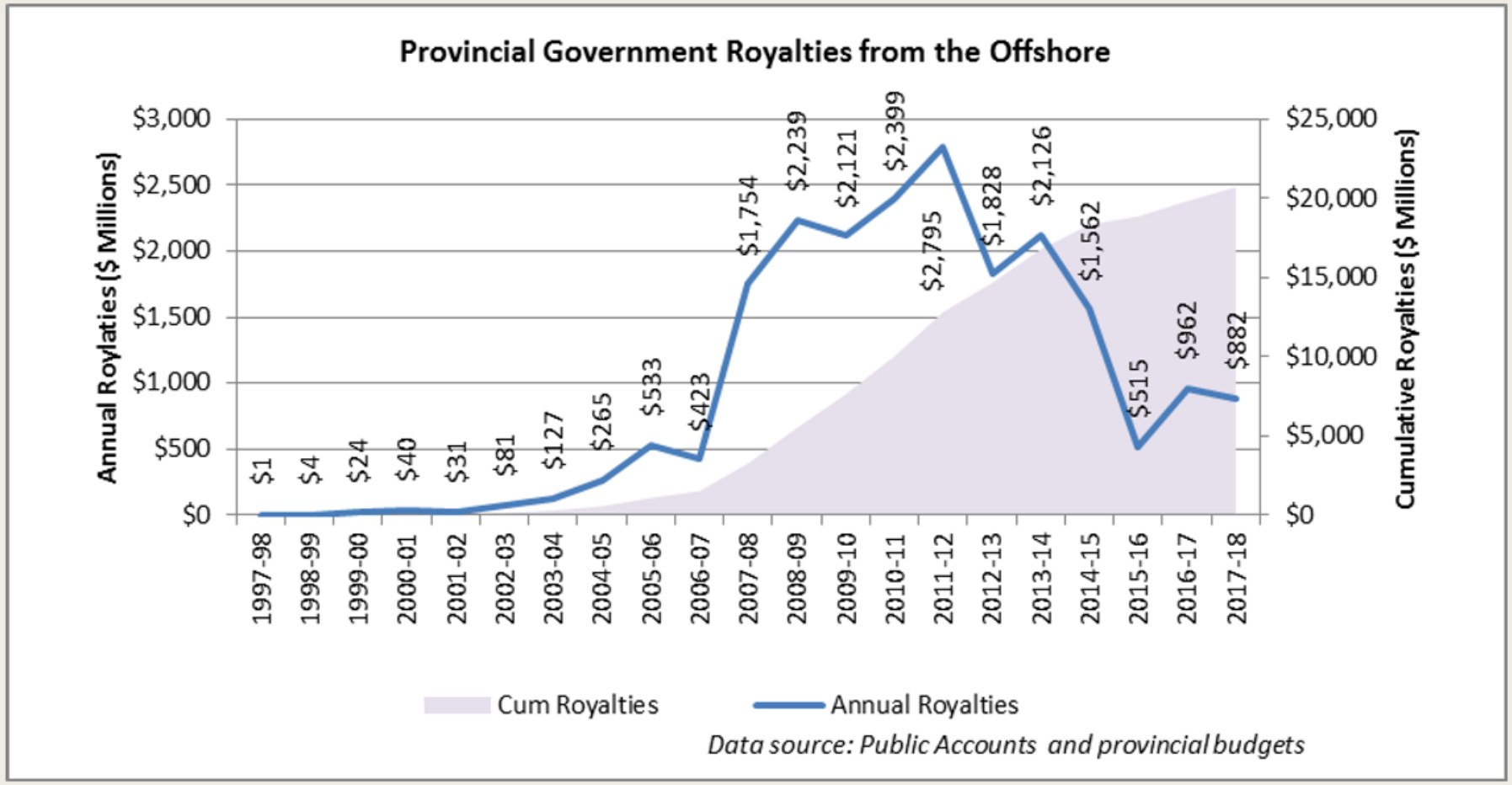




Robbie Andrew

Part 3: The Province

Oil and Royalties



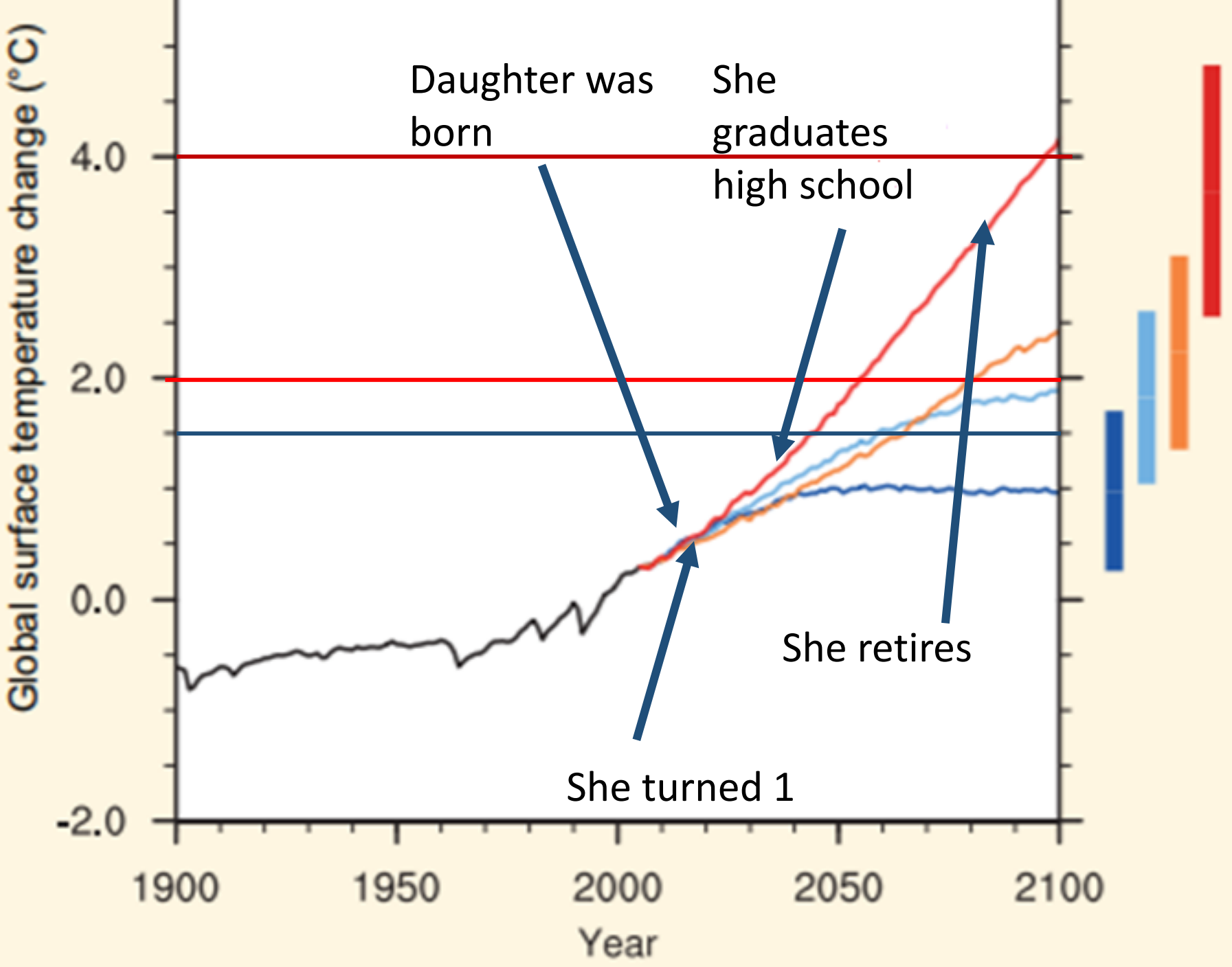
From its peak in 2011-12, oil royalties have fallen by 79%

Masoudi (2017)

We need to:

DECARBONIZE
NEWFOUNDLAND
& LABRADOR

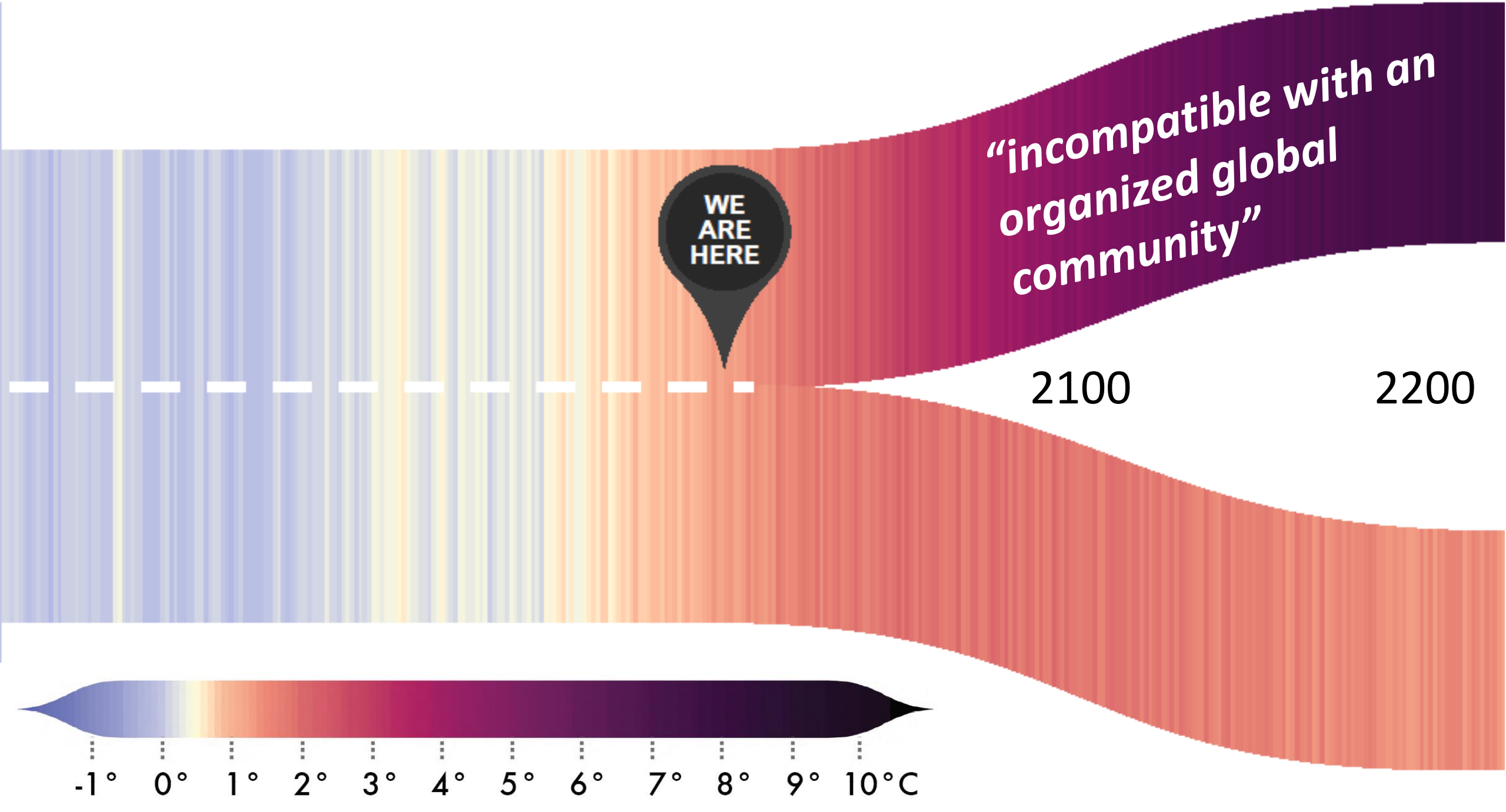
1. Justice
2. Environmental
3. Economic self-interest



4 degree

2 degree limit

1.5 degree safest limit


WE ARE HERE
"incompatible with an organized global community"
2100
2200
-1° 0° 1° 2° 3° 4° 5° 6° 7° 8° 9° 10°C

The children will not go gentle into that good night

Photo:
Renee
Ryan

March 2019

Sept 2019

Dec 2019

2. Environmental

Nfld. & Labrador

Lobster – the 'Rolls-Royce of shellfish' – has promising future for N.L. exporters

'Lobster might become one of the most important fisheries in Newfoundland,' says researcher

Marie Isabelle Rochon · CBC News · Posted: Feb 03, 2020 7:00 AM NT | Last Updated: February 3

Warmer waters are getting part of the credit for an uptick in lobsters off the coast of Newfoundland, and some companies are betting big on the crustacean's future.

"We are projecting that in five years, this fishery in the province will exceed $100 million in landed value, which is phenomenal, quite frankly," Decker said.

"Because of global warming, the resource itself is moving farther north all the time every year."

The New York Times

"Climate change really helped us for the last 20 years," said Dave Cousens, who stepped down as president of the Maine Lobstermen's Association in March. But, he added, "Climate change is going to kill us, in probably the next 30."

Climate Change Brought a Lobster Boom. Now It Could Cause a Bust.

Dave Cousens, a lobsterman, begins his day before sunrise in South Thomaston, Me. Greta Rybus for The New York Times

3. Economic self-interest

MOTHERBOARD
TECH BY VICE

Government Agency Warns Global Oil Industry Is on the Brink of a Meltdown

We are not running out of oil, but it's becoming uneconomical to exploit it – another reason we need to move to renewables as quickly as possible.

By **Nafeez Ahmed**

> “To phase out petroleum products (and fossil fuels in general), the entire global industrial ecosystem will need to be reengineered, retooled and fundamentally rebuilt," the report notes. "This will be perhaps the greatest industrial challenge the world has ever faced historically.”

Oil from a Critical Raw Material Perspective

Simon Michaux

Geological Survey of Finland
Unit
Place of business

22.12.2019

GTK Open File Work
Report 70/2019

Alberta Government

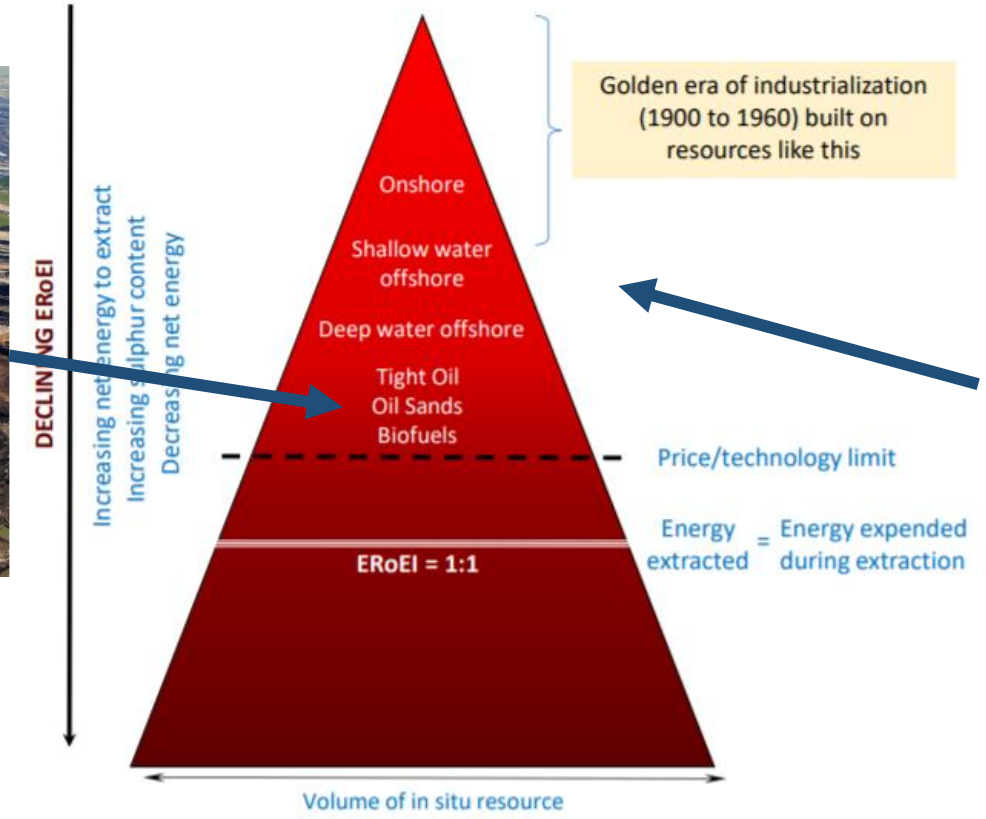


Figure 186. The pyramid of oil and gas resource volume versus resource quality

The Way Forward on oil and gas
Newfoundland Labrador

Report: http://tupa.gtk.fi/raportti/arkisto/70_2019.pdf

Bloomberg
@business

BREAKING: Oil drops below $2 a barrel trib.al/3SdLNfD

2:02 PM · Apr 20, 2020 · SocialFlow

Macro-trends:

1. Massive growth in clean tech

…which leads to…

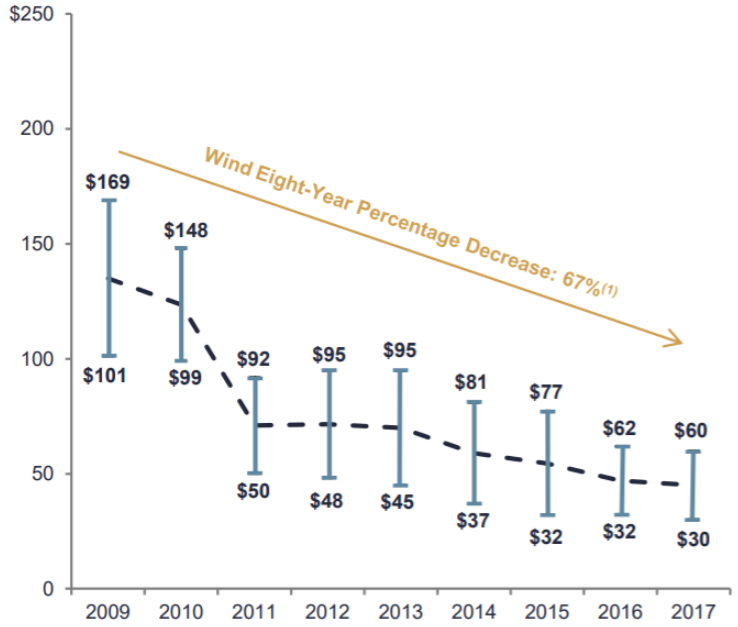
2. Failure of the petroleum sector

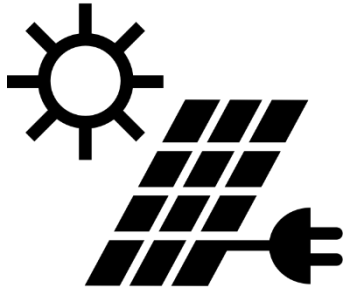
…which will occur against a backdrop of…

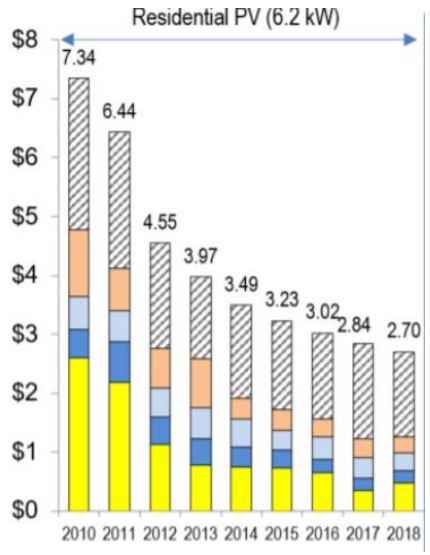
3. Ongoing rapid change

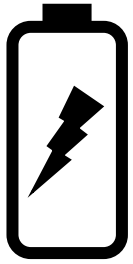
1. Massive growth in clean tech

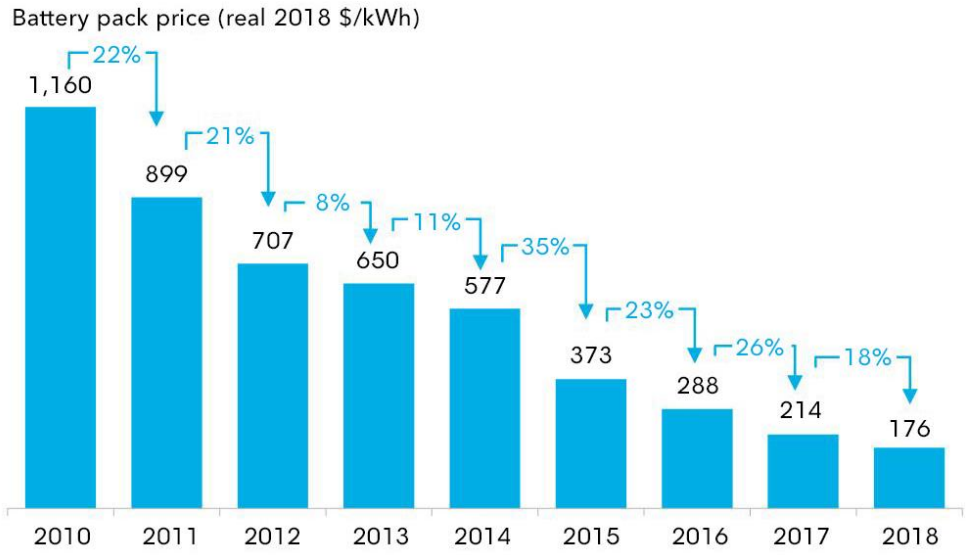
$ / MWh







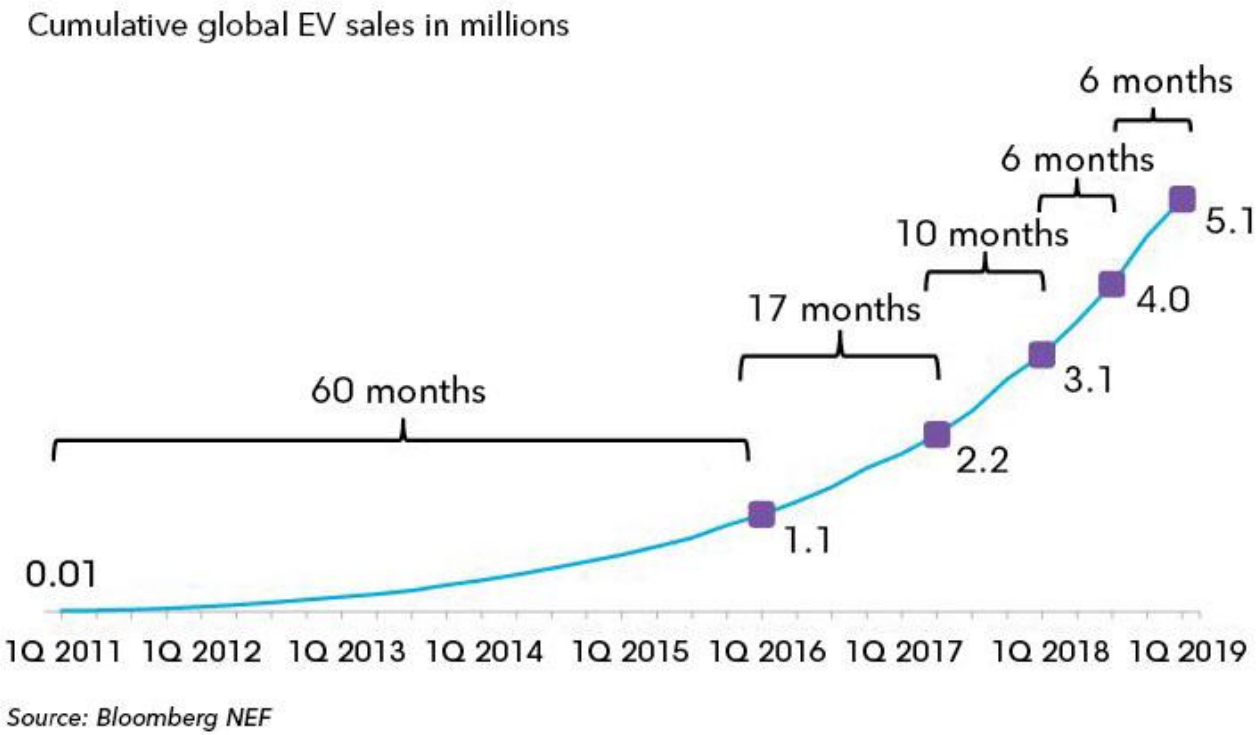




Source: BloombergNEF

Let’s talk electric cars

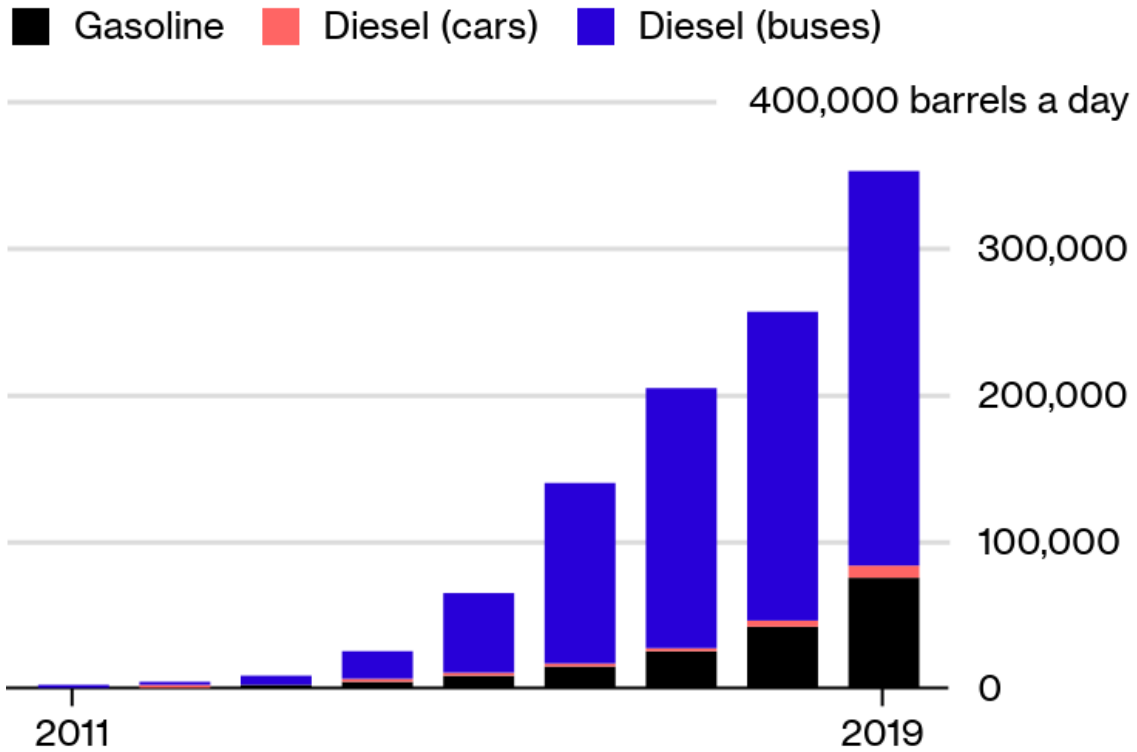
Figure 6: The time to sell a million EVs is shortening



Source: Bloomberg NEF

Disappearing Demand

Electric vehicles are increasingly displacing petroleum consumption



Source: BloombergNEF

Bloomber

The New York Times

Oil Companies Are Collapsing, but Wind and Solar Energy Keep Growing

The renewable-energy business is expected to keep growing, though more slowly, in contrast to fossil fuel companies, which have been hammered by low oil and gas prices.

Three macro-trends:

1. Massive growth in clean tech

…which leads to…

2. Failure of the petroleum sector

…which will occur against a backdrop of…

3. Ongoing rapid change

Nfld. & Labrador

Hibernia drilling to stop for as long as 18 months as cost-saver, but production will continue

Oil giant releasing very few details, but unions predicts mass layoffs

Terry Roberts · CBC News · Posted: Apr 07, 2020 6:23 PM NT | Last Updated: April 7

Local News

Husky Shuts Down West White Rose Project at Argentia

March 22, 2020 06:22 pm

Newfoundland offshore Bay du Nord project deferred indefinitely

David Maher (david.maher@thetelegram.com)
Published: Mar 18 at 2:28 p.m.

Nfld. & Labrador

Come By Chance refinery stopping production due to COVID-19, economic concerns

The refinery supplies propane, jet fuel to N.L.

CBC News · Posted: Mar 30, 2020 7:22 AM NT | Last Updated: March 30

The Narwhal

OPINION

Canada's fossil fuel subsidies amount to $1,650 per Canadian. It's got to stop.

Prime Minister Justin Trudeau's vow to phase out 'inefficient' subsidies for coal, oil and gas still hasn't happened — despite the escalating costs of the climate emergency

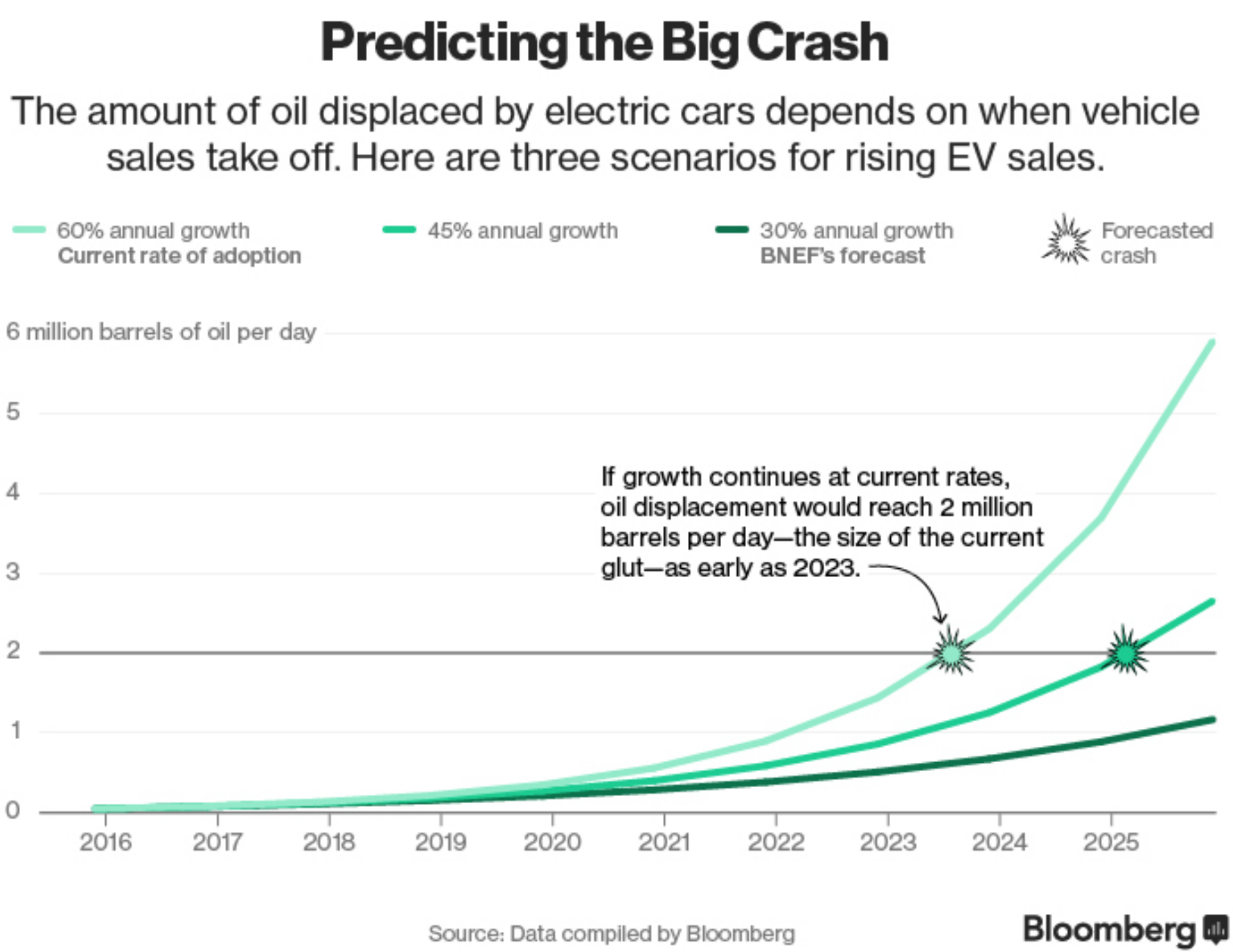
• Oct 3, 2019

4 min read

By Erin Gray and Calvin Sandborn, lawyers at the University of Victoria Environmental Law Centre and Emilie Benoit and Sydney Hamilton, students at the University of Victoria Environmental Law Centre.

Fewer gas-powered vehicles means less oil demand

Less demand can crash oil prices. **2014's crash occurred with only a 2M barrel per day oversupply.**



Three macro-trends:

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Upcoming tipping points:

RESEARCH ARTICLE

Social tipping dynamics for stabilizing Earth's climate by 2050

Ilona M. Otto, Jonathan F. Donges, Roger Cremades, Avit Bhowmik, Richard J. Hewitt, Wolfgang Lucht, Johan Rockström, Franziska Allerberger, Mark McCaffrey, Sylvanus S. P. Doe, Alex Lenferna, Nerea Morán, Detlef P. van Vuuren, and Hans Joachim Schellnhuber

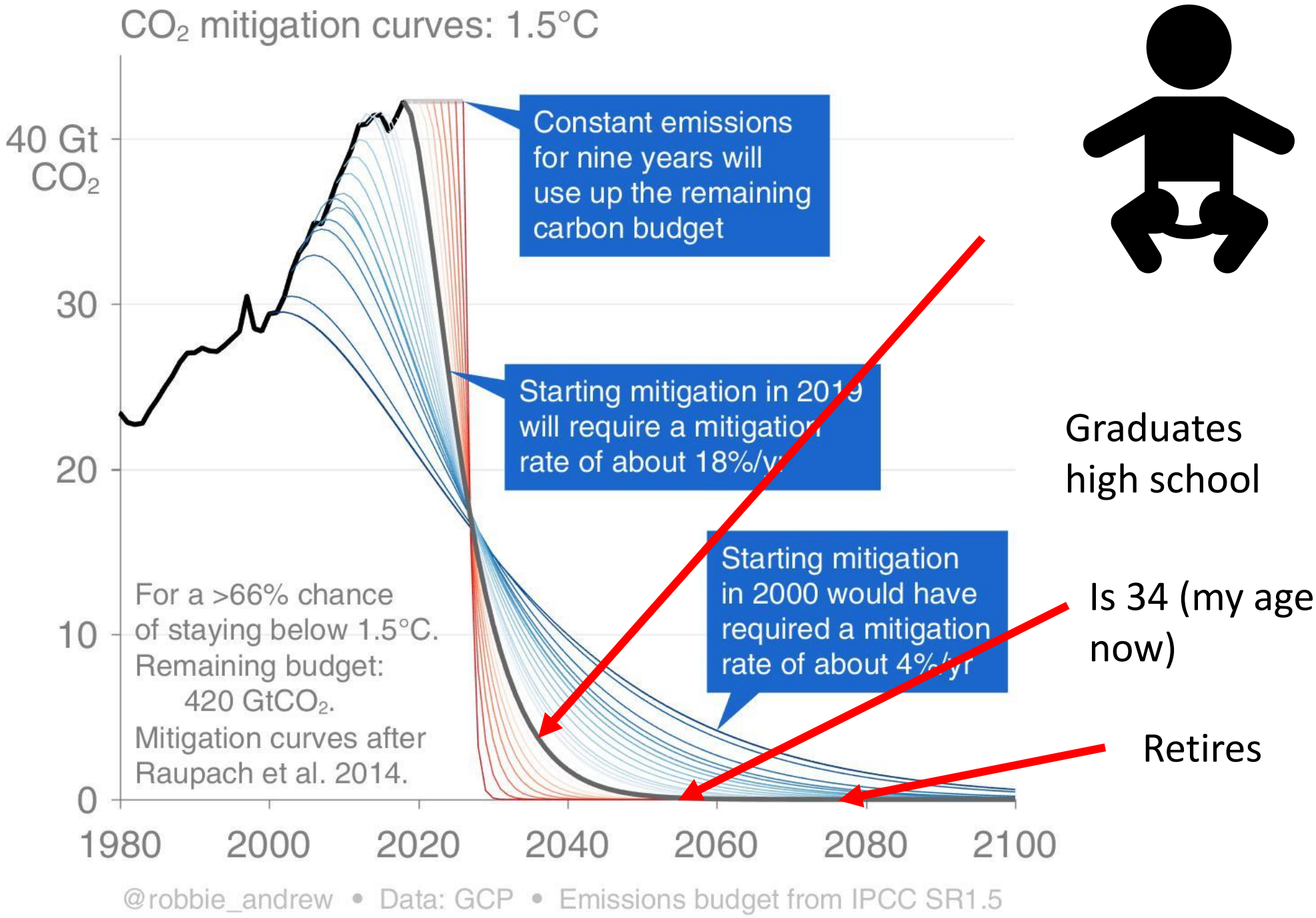
PNAS February 4, 2020 117 (5) 2354-2365; first published January 21, 2020
https://doi.org/10.1073/pnas.1900577117

Contributed by Hans Joachim Schellnhuber, November 15, 2019 (sent for review January 22, 2019; reviewed by J. David Tabara and Jessika E. Trancik)

Article | Figures & SI | Info & Metrics | PDF

The STIs that could trigger the tipping of STE subsystems include

1) **removing fossil-fuel subsidies** and incentivizing decentralized energy generation
2) **building carbon-neutral cities** and **divesting from assets** linked to fossil fuels
3) revealing the **moral implications** of fossil fuels
4) strengthening **climate education** and engagement
5) **disclosing information** on greenhouse gas emissions



Graduates high school

Is 34 (my age now)

Retires

Nothing makes sense except in light of climate change…

So get involved!

Thank you

@LetsFishSmarter