How Can Markets Capture the Social Benefits of Carbon Dioxide as Well as the Costs?

MATT

“There are no solutions, there are only trade-offs; and you try to get the best trade-off you can get, that's all you can hope for.”

Thomas Sowell

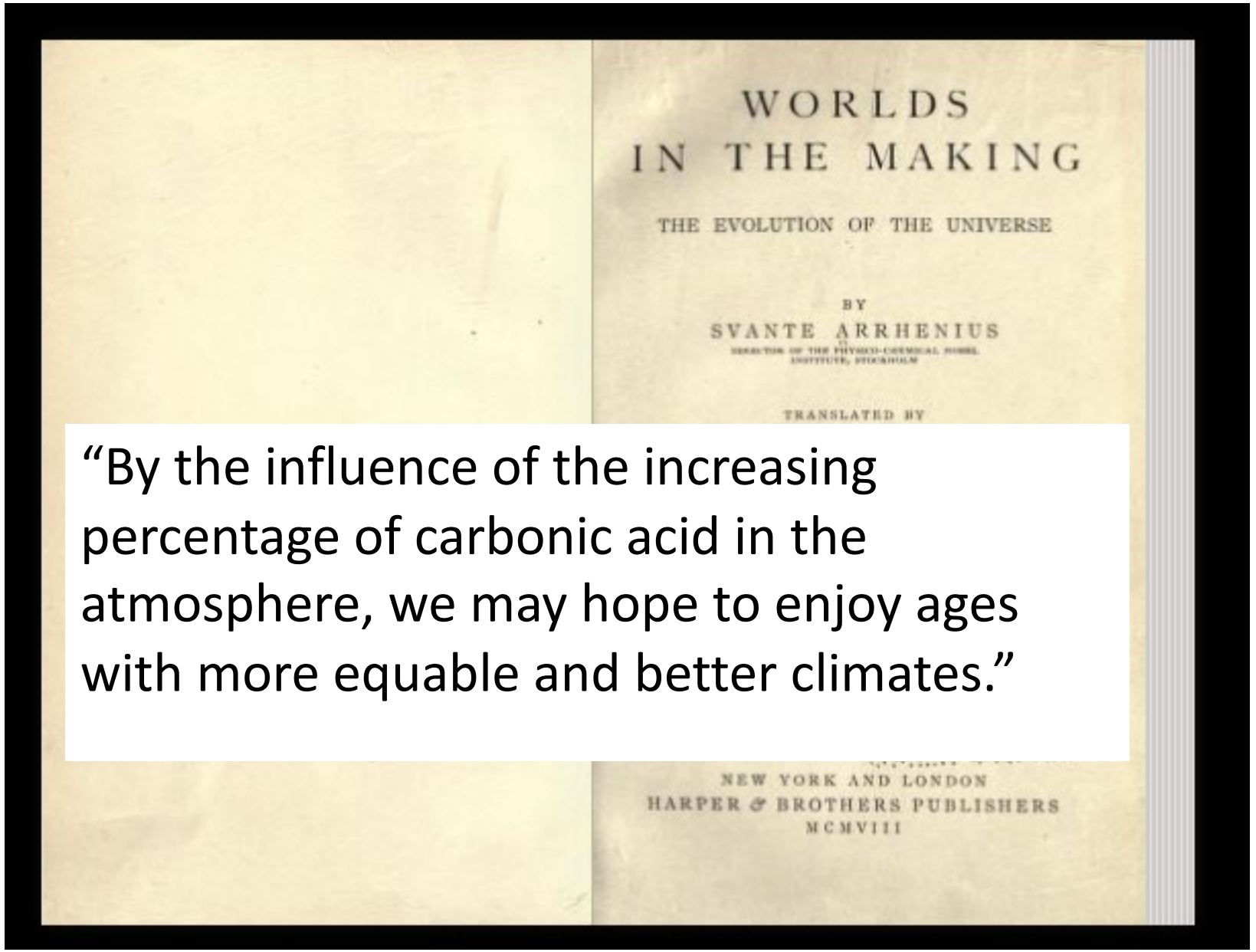
Costs and benefits, trade-offs and opportunity costs…

Costs

- Rising sea level
- Longer heat waves
- Worse floods
- More severe droughts
- More frequent storms
- More forest fires
- Ocean acidification

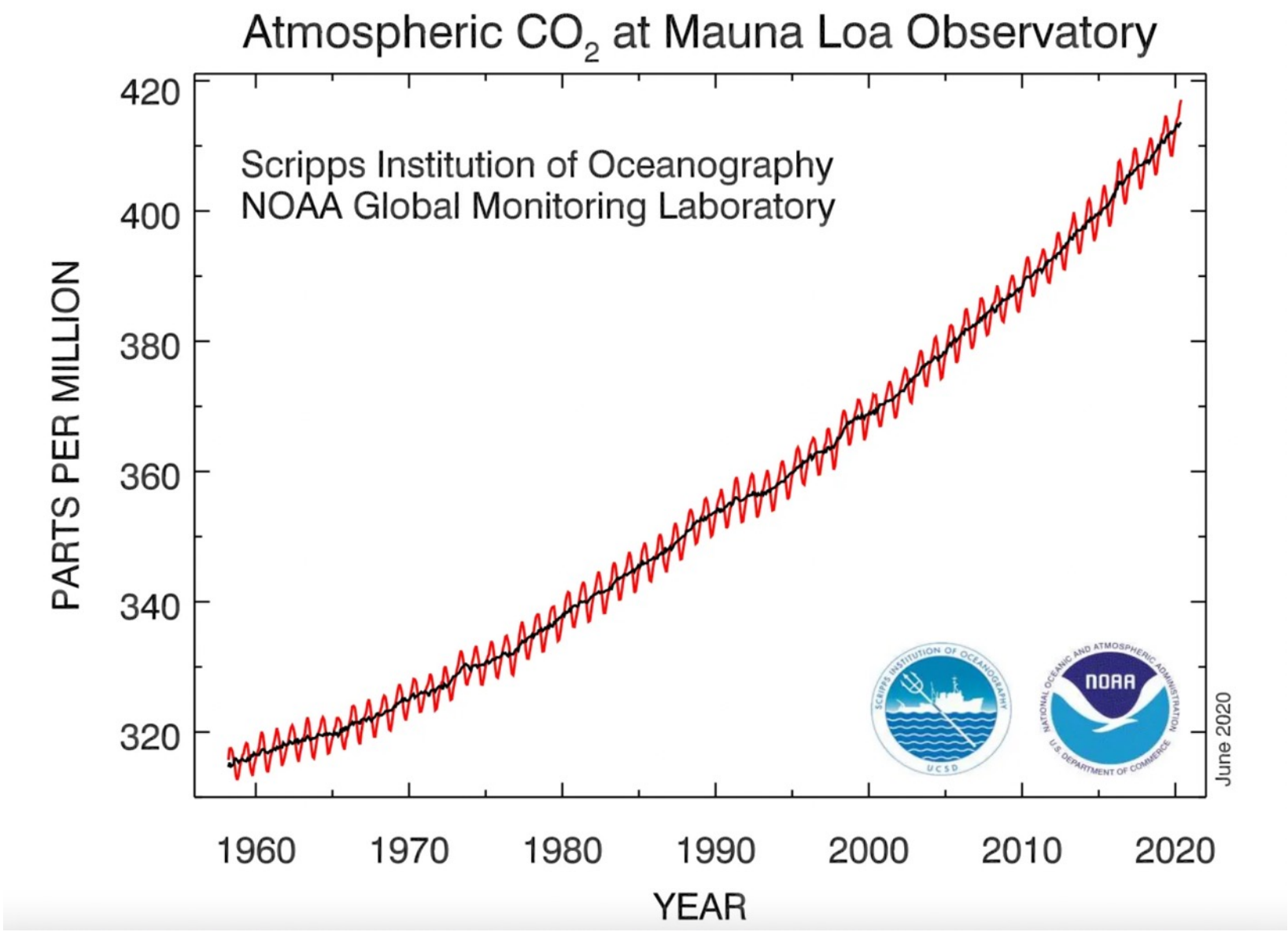
Benefits

- Global greening
- Ocean productivity
- Water use efficiency
- Higher yields - land sparing
- Reduced cold deaths
- Longer growing seasons
- [Avoided decarbonisation costs]



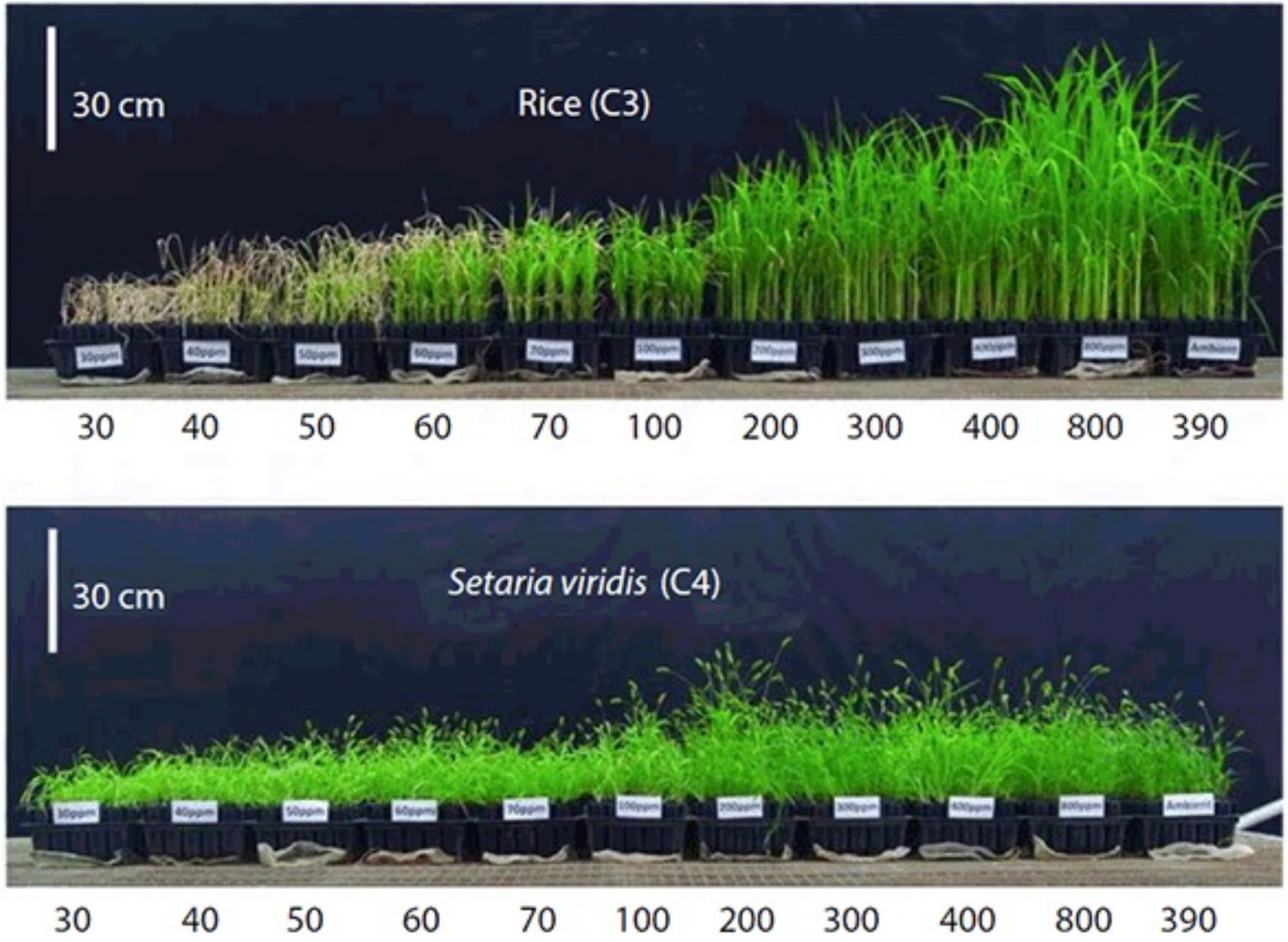
"By the influence of the increasing percentage of carbonic acid in the atmosphere, we may hope to enjoy ages with more equable and better climates."

0.04%


Atmospheric CO_2 at Mauna Loa Observatory
Scripps Institution of Oceanography
NOAA Global Monitoring Laboratory
PARTS PER MILLION
420
400
380
360
340
320
1960
1970
1980
1990
2000
2010
2020
YEAR
June 2020

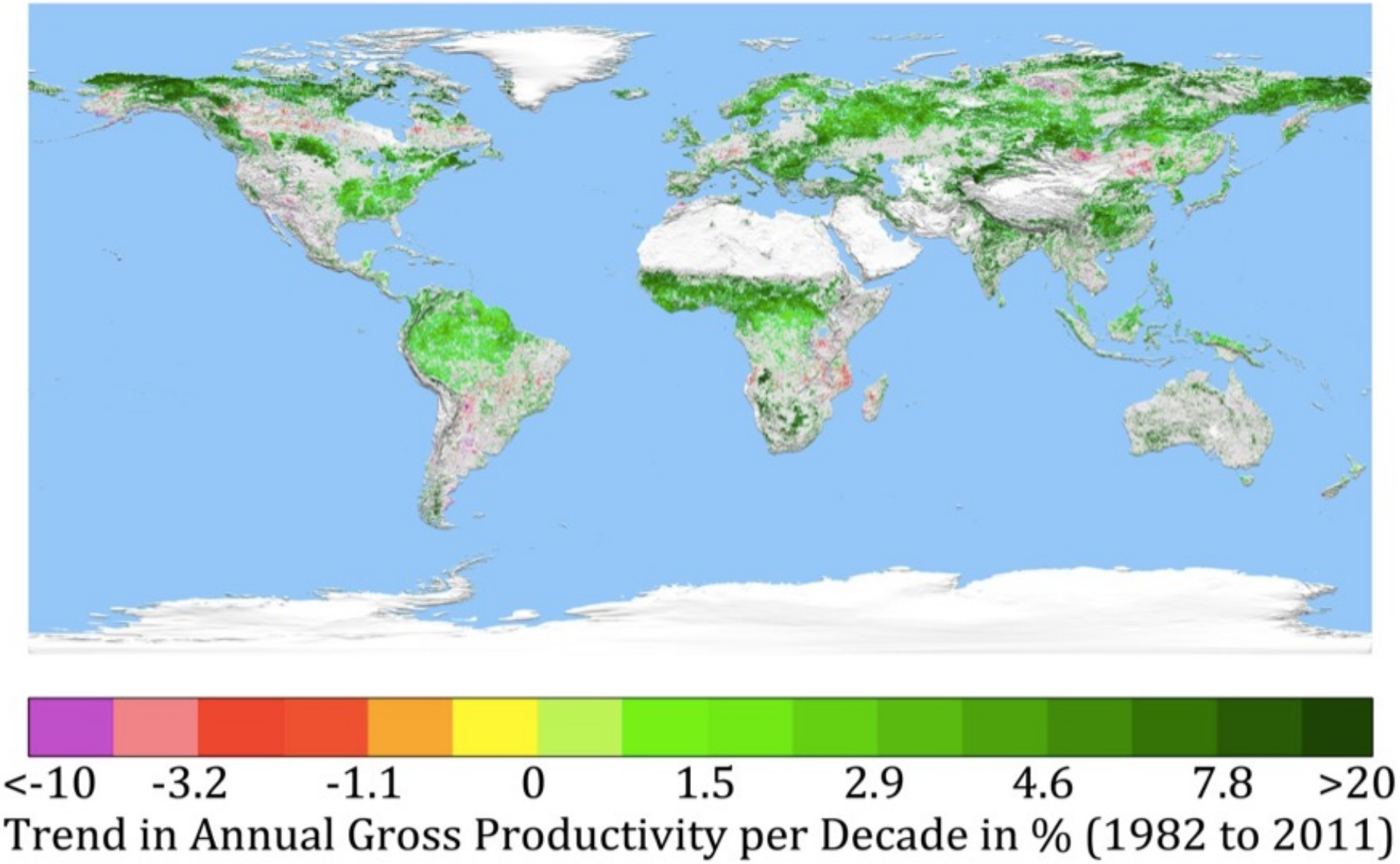
0.03%

The CO2 fertilisation effect



Parts per million CO2

Global greening



http://probing.vegetation.be/sites/default/files/pdf/dag1/1100-Ranga%20Myneni-myneni-probing-vegetation-talk-2.pdf

By How Much did the Earth Green over the Past 30 years?

IGBP Land Cover Classes	Area			Productivity	
	G (%)	B (%)	N (%)	I (%)	D (%)
Evergreen broadleaf forests	5.62	0.15	7.10	2.27	-0.04
Deciduous broadleaf forests	0.54	0.09	0.95	0.23	-0.05
Cropland/Natural vegetation mosaics	2.27	0.13	4.30	1.26	-0.09
Savannas	1.67	0.40	6.03	0.94	-0.16
Mixed forests	3.56	0.40	8.33	1.96	-0.19
Woody savannas	2.85	0.05	2.96	1.22	-0.03
Croplands	3.41	0.21	7.15	1.75	-0.12
Closed shrublands	1.80	0.19	3.36	0.68	-0.06
Evergreen needleleaf forests	0.92	0.01	1.15	0.25	0.00
Deciduous needleleaf forests	0.18	0.09	1.07	0.11	-0.07
Grasslands	2.86	0.48	10.53	1.08	-0.18
Open shrublands	5.18	0.57	13.39	1.80	-0.22
Total	30.87	2.76	66.32	13.54	-1.21

- 31% of the global vegetated area greened
- This greening translates to a 14% increase in gross productivity
- The greening is seen in all vegetation types

http://probing.vegetation.be/sites/default/files/pdf/dag1/1100-Ranga%20Myneni-myneni-probing-vegetation-talk-2.pdf

THE WALL STREET JOURNAL.


THE MIDDLE SEAT
Why the Big Three Airlines Are So Much the Same

Your Used iPhone or iPad Isn't Dead Yet


Tall and Tan and Young...and Miffed


Wardrol
Men as
Goes Ca

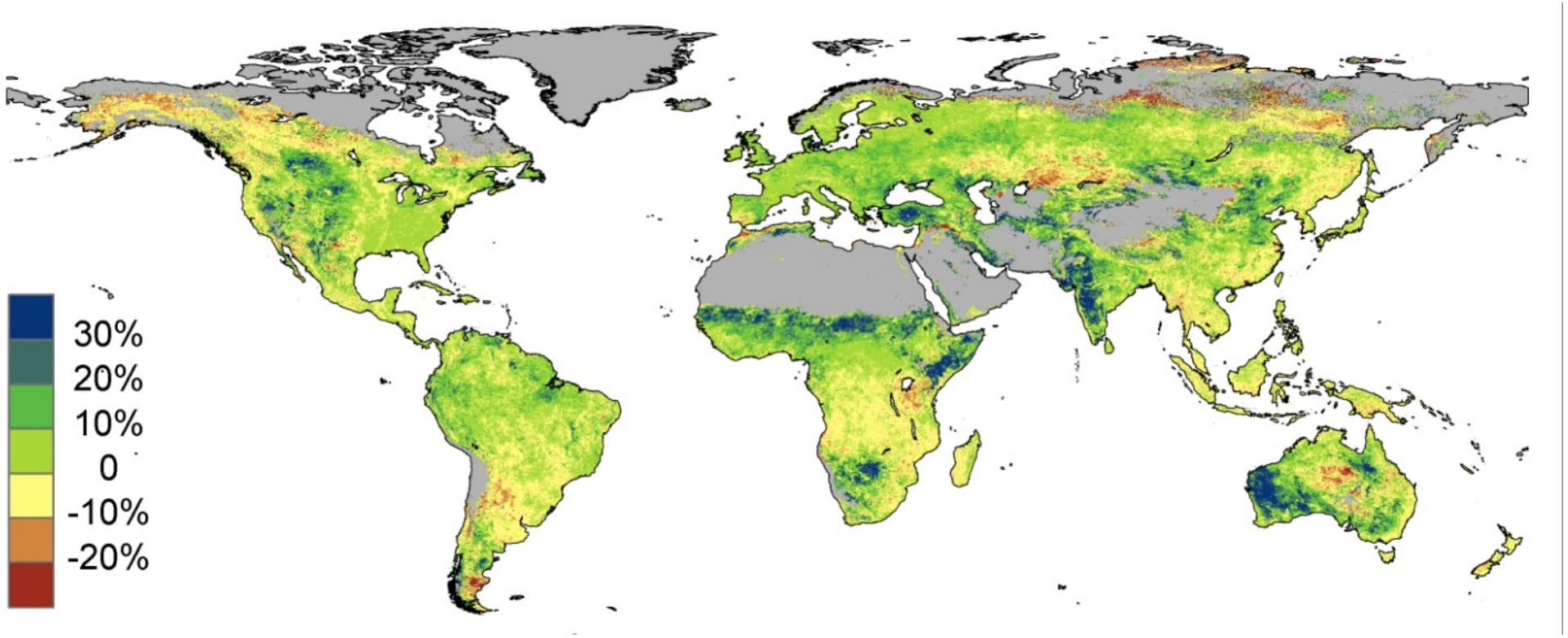
MIND & MATTER

How Fossil Fuels Have Greened the Planet

By MATT RIDLEY
Jan. 4, 2013 9:40 p.m. ET

Did you know that the Earth is getting greener, quite literally? Satellites are now confirming that the amount of green vegetation on the planet has been increasing for three decades. This will be news to those accustomed to alarming tales about deforestation, overdevelopment and ecosystem destruction.

This possibility was first suspected in 1985 by Charles Keeling, the scientist whose meticulous record of the content of the air atop Mauna Loa in Hawaii first alerted the world to the increasing concentration of carbon dioxide in the atmosphere. Mr. Keeling's

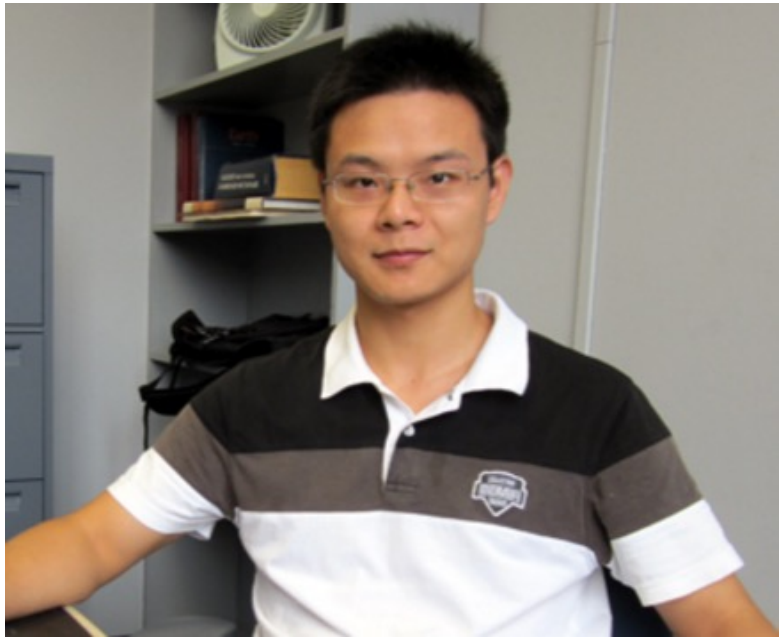


"Our work was able to tease-out the CO2 fertilization effect by using mathematical modeling together with satellite data adjusted to take out the observed effects of other influences such as precipitation, air temperature, the amount of light, and land-use changes." – R. Donohue, 2013

http://onlinelibrary.wiley.com/doi/10.1002/grl.50563/abstract

“The greening over the past 33 years reported in this study is equivalent to adding a green continent about two times the size of mainland USA (18 million km2).”

Zaichun Zhu, Beijing University, 2016



70% of greening attributable to higher CO2 levels

PUBLIC RELEASE: 25-APR-2016

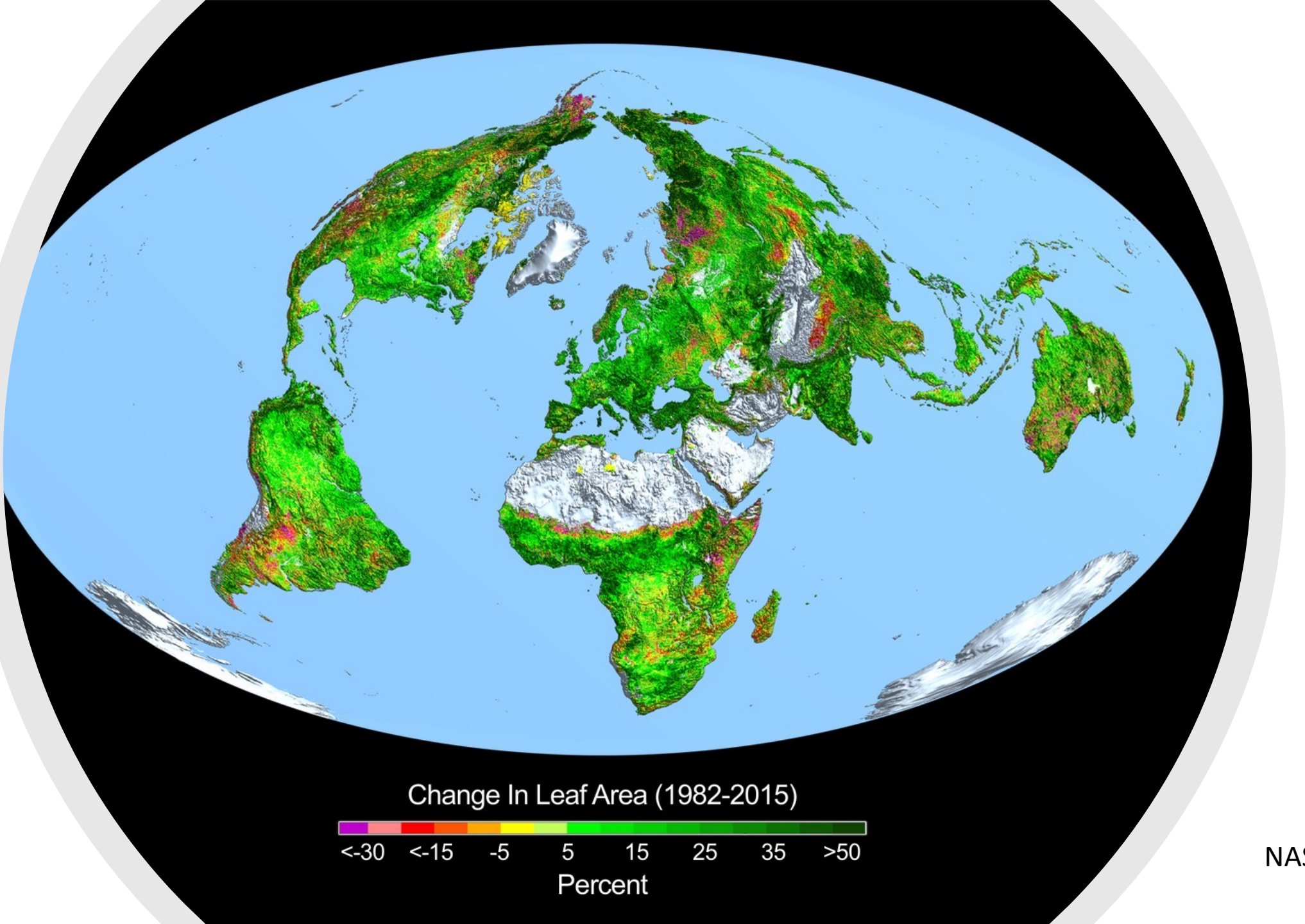
CO2 fertilization greening the earth

International team reports CO2 fertilization prompted plants and trees to sprout extra green leaves equivalent in area to two times the continental USA, or nearly 4.4 billion General Shermans (largest giant Sequoia tree)

BOSTON UNIVERSITY

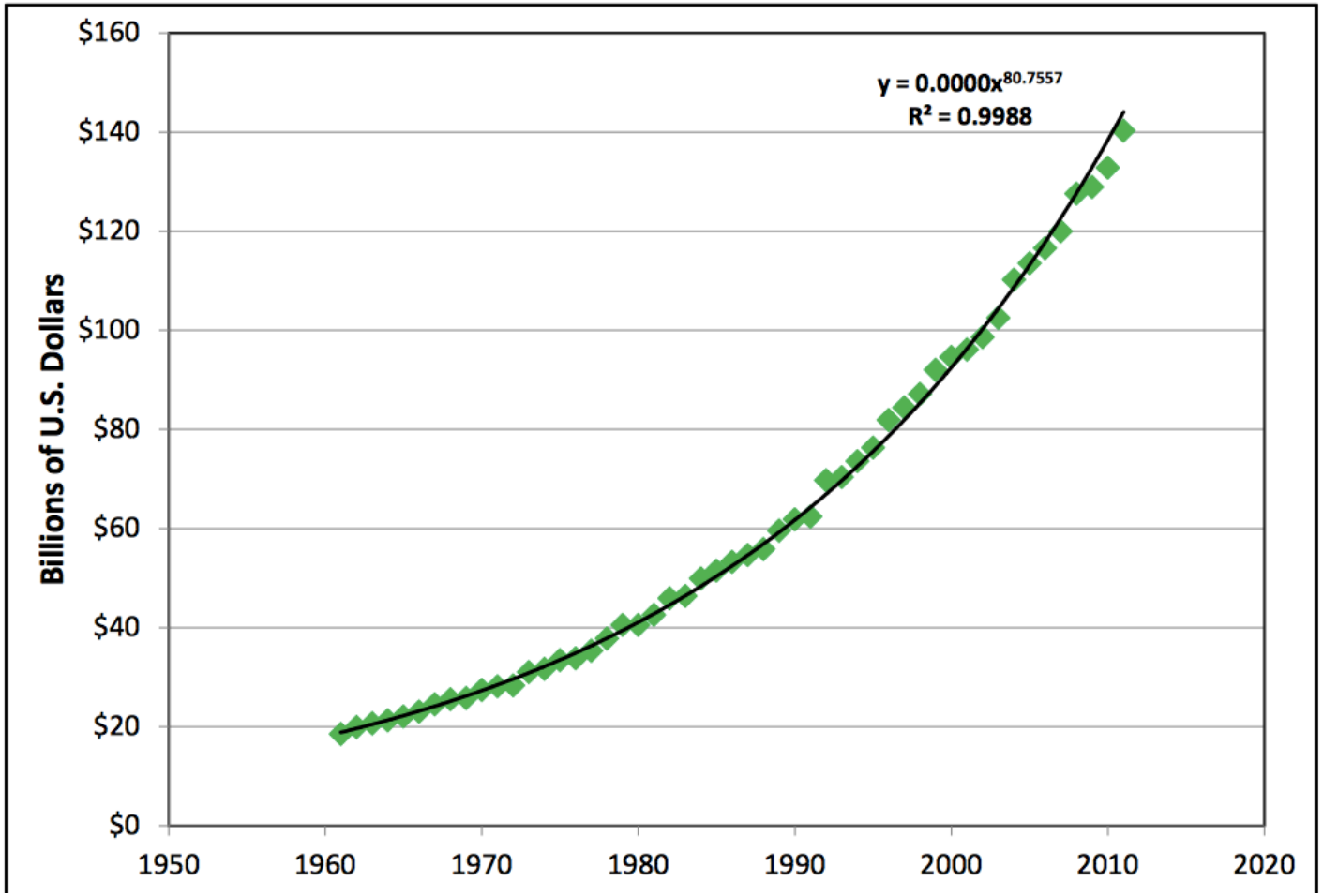
BOSTON -- An international team of 32 authors from 24 institutions in eight countries has just published a study titled "Greening of the Earth and its Drivers" in the journal *Nature Climate Change* showing significant greening of a quarter to one-half of the Earth's vegetated lands using data from the NASA-MODIS and NOAA-AVHRR satellite sensors of the past 33 years. The

The beneficial aspect of CO2 fertilization in promoting plant growth has been used by contrarians, notably Lord Ridley (hereditary peer in the UK House of Lords) and Mr. Rupert Murdoch (owner of several news outlets), to argue against cuts in carbon emissions to mitigate climate change, similar to those agreed at the 21st Conference of Parties (COP) meeting in Paris last year under the UN Framework on Climate Change (UNFCCC). "The fallacy



NASA

Total annual monetary value of the direct CO2 benefit on crop production for 45 crops



http://www.co2science.org/education/reports/co2benefits/MonetaryBenefitsofRisingCO2onGlobalFoodProduction.pdf

Drought resistance improves with higher CO2

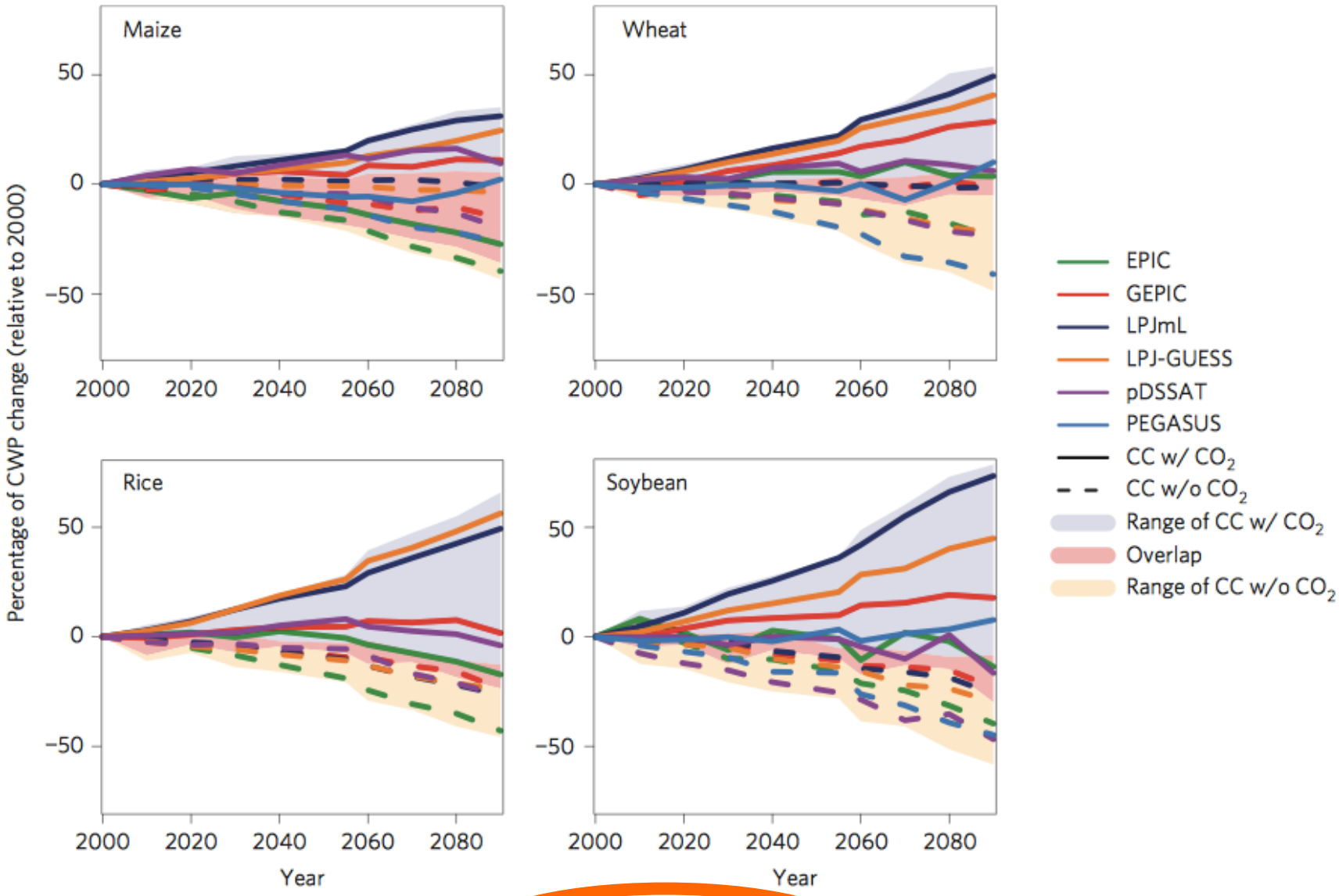
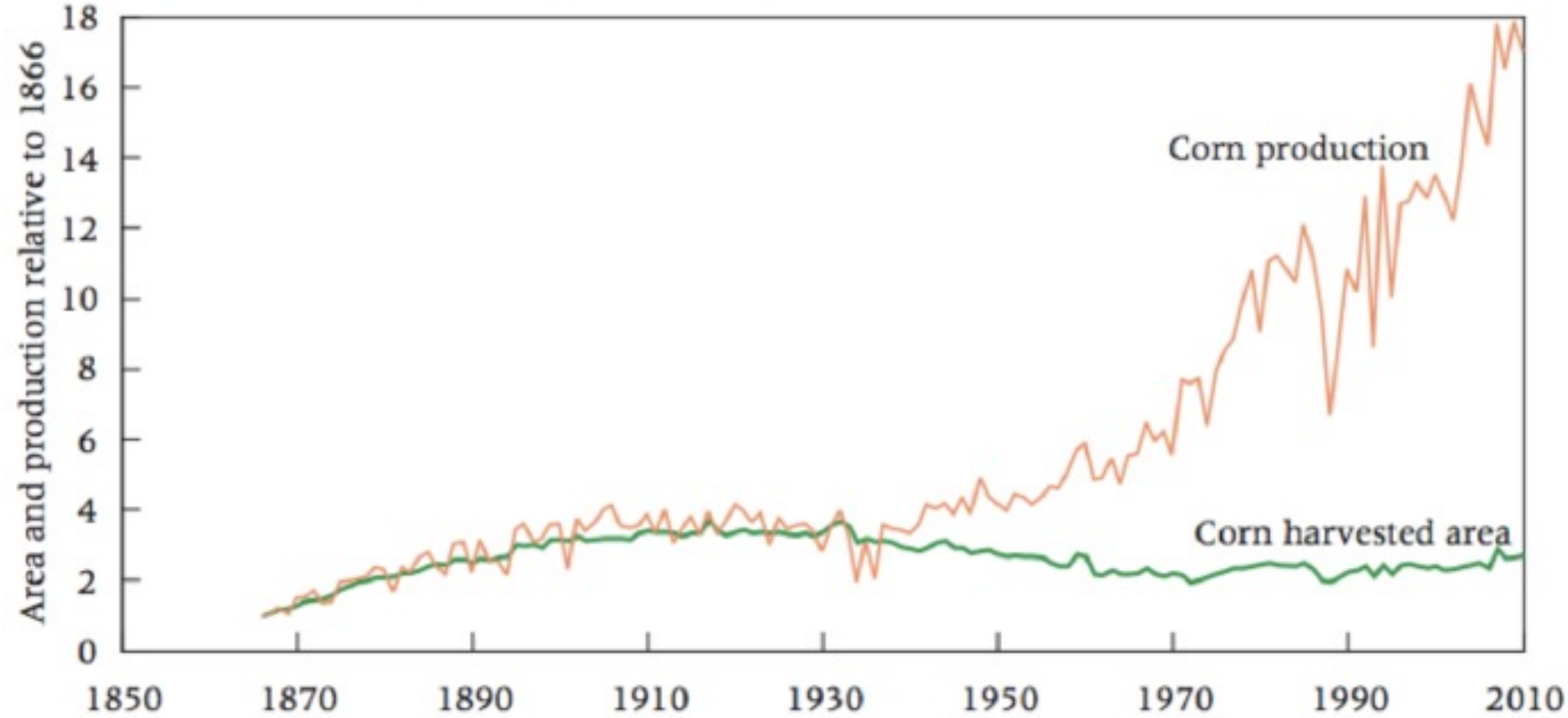


Figure 4 | Global average CWP (%) relative to 2000 simulated under RCP 8.5 for each GGCM driven by five different GCMs. Solid lines show median CWP under both climate change and CO_2 effects, whereas dashed lines show median CWP under climate change effects only—that is, with constant [CO_2]. Shaded areas show the range across the GGCM–GCM ensemble under CC w/o CO_2 (yellow) and CC w/ CO_2 (blue), distinctively, and overlap between CC w/o CO_2 and CC w/ CO_2 (red).

Area of corn harvested and corn production, United States 1866–2010 (indexes, 1866 = 1)



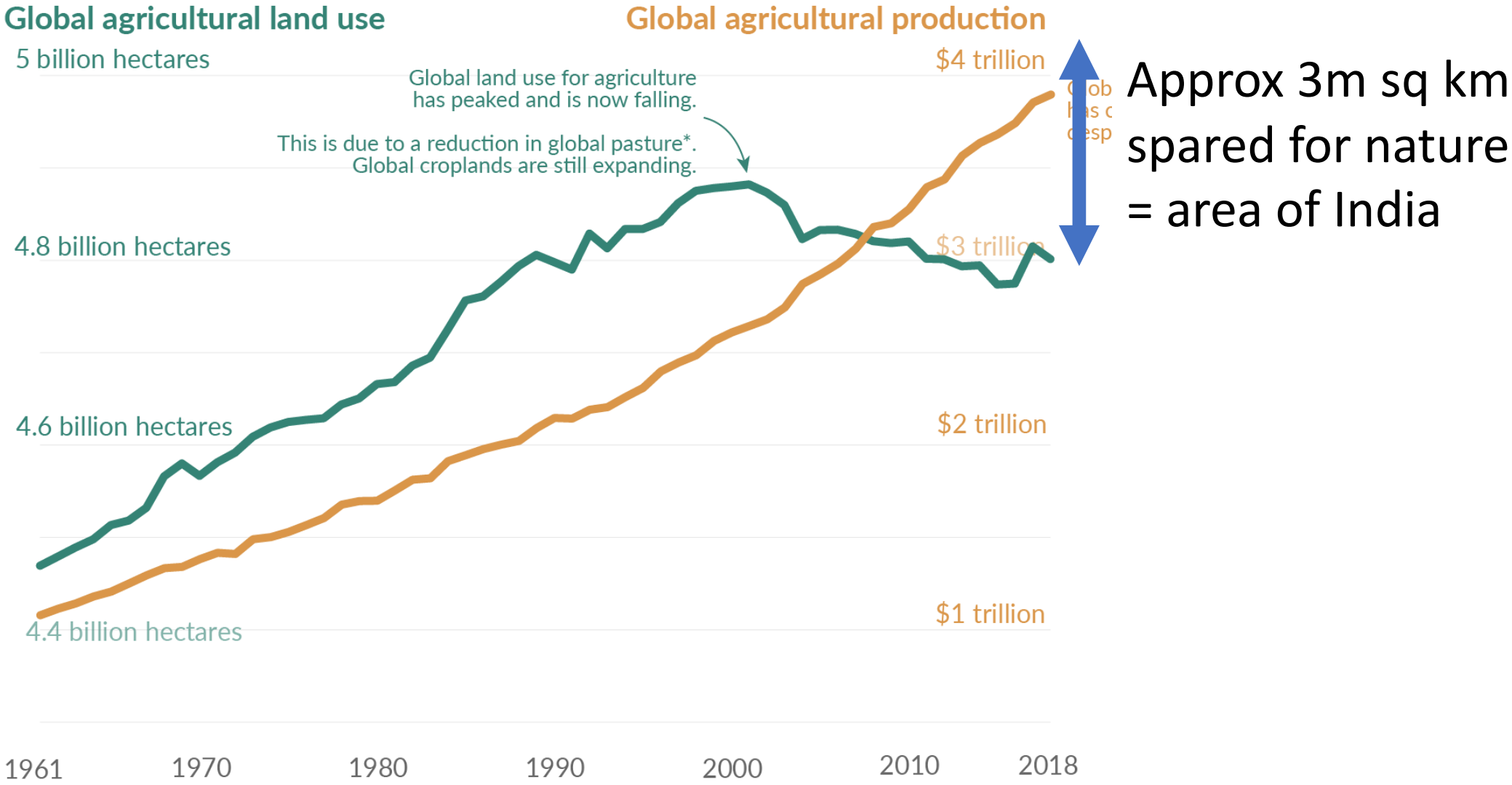
SOURCE: US Bureau of the Census (1975, 2012).

http://phe.rockefeller.edu/docs/PDR.SUPP%20Final%20Paper.pdf

Global decoupling of agricultural land and food production

Our World in Data

Agricultural land is the sum of cropland and pasture for grazing livestock.
Production is measured in constant 2015 international-dollars, which adjusts for inflation. Includes all crops and livestock.



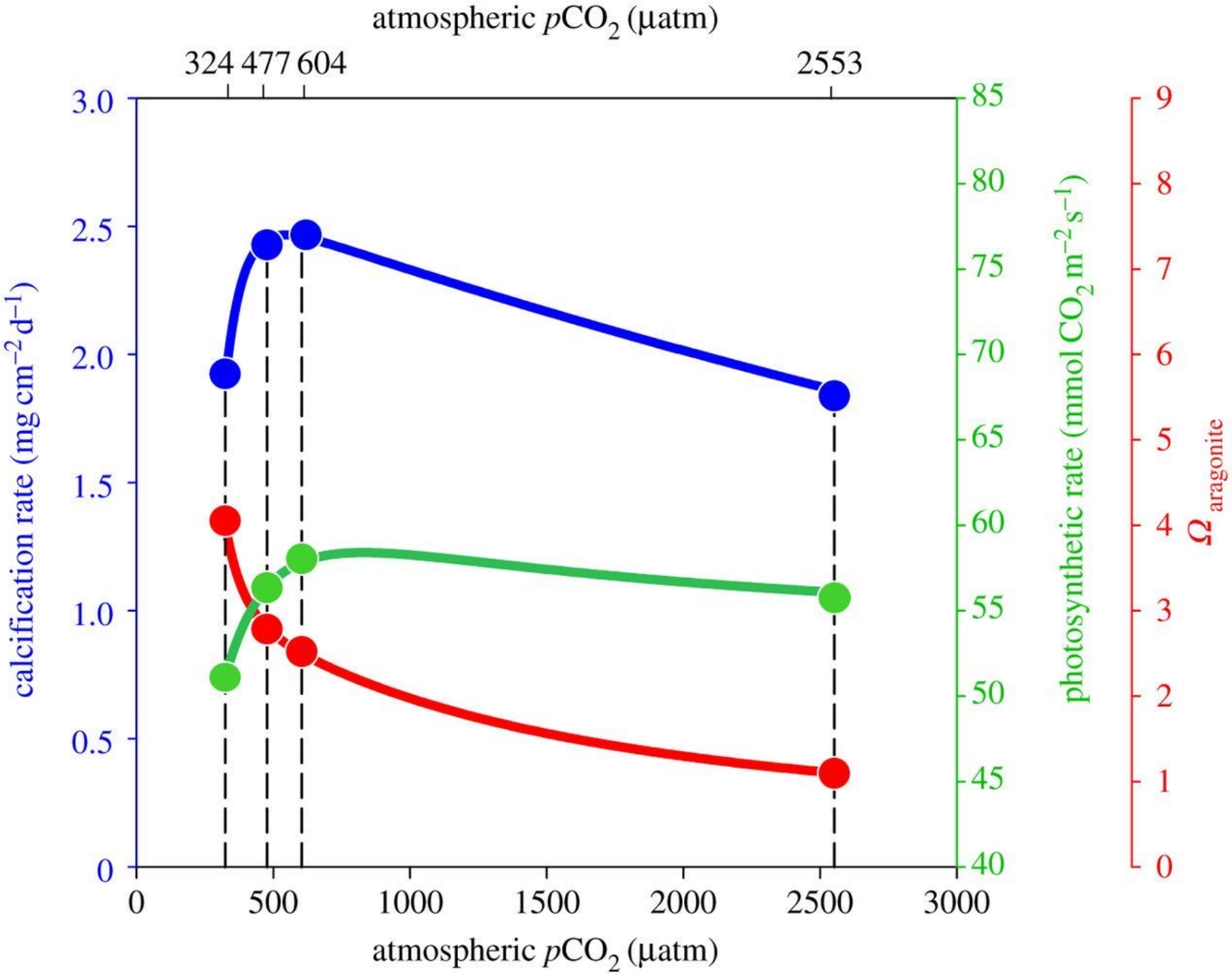
Approx 3m sq km spared for nature = area of India

*A peak in global pasture land does not mean that it has peaked everywhere. In tropical regions, it continues to increase, often at the expense of carbon-rich habitats.

Data source: Food and Agriculture Organization of the United Nations.

OurWorldinData.org – Research and data to make progress against the world's largest problems.

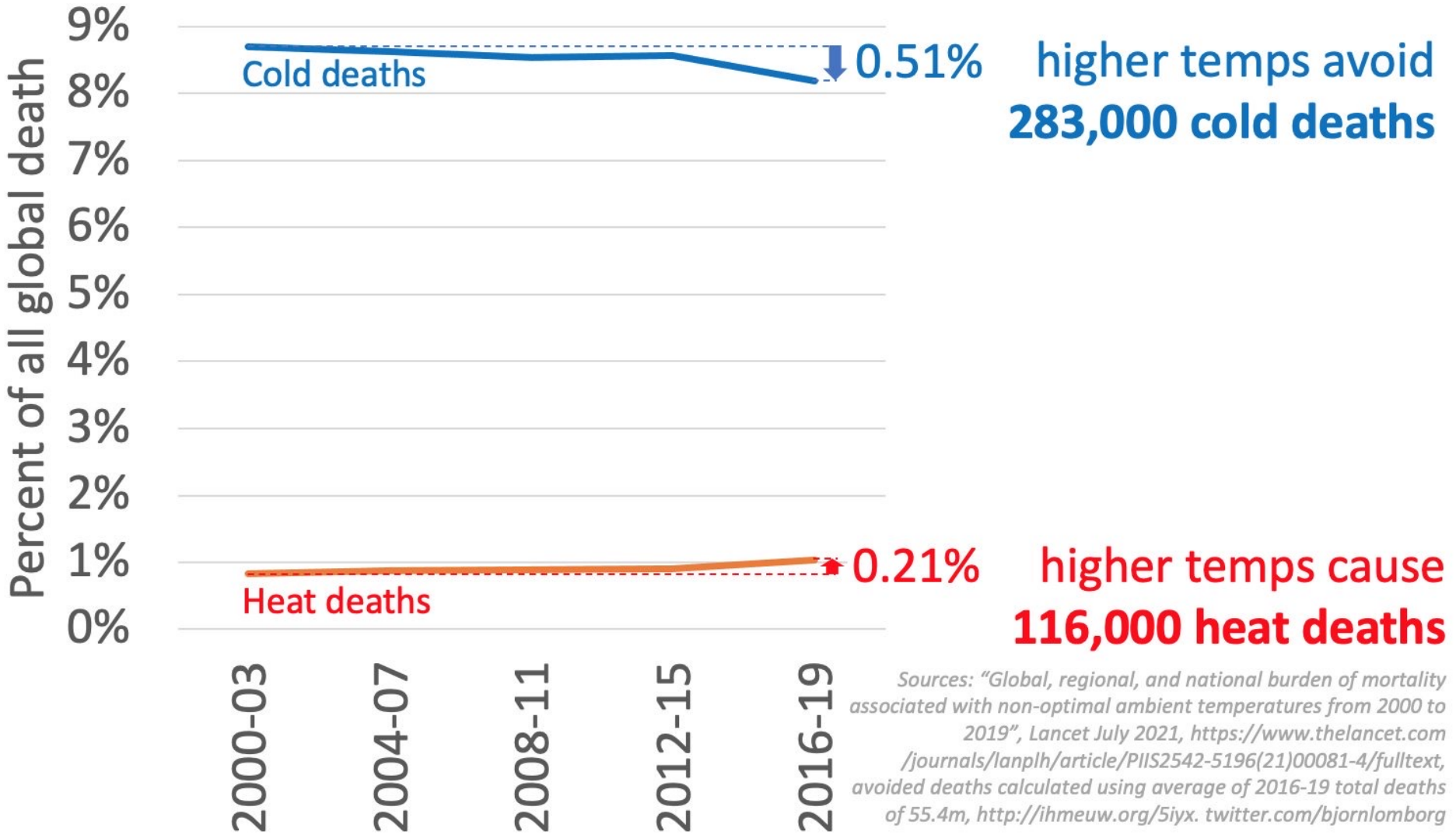
Productivity of coral



https://royalsocietypublishing.org/doi/10.1098/rspb.2014.1856

Lancet: Each year warming **saves 166,000 lives**

Mortality is higher in cold seasons even in hot countries

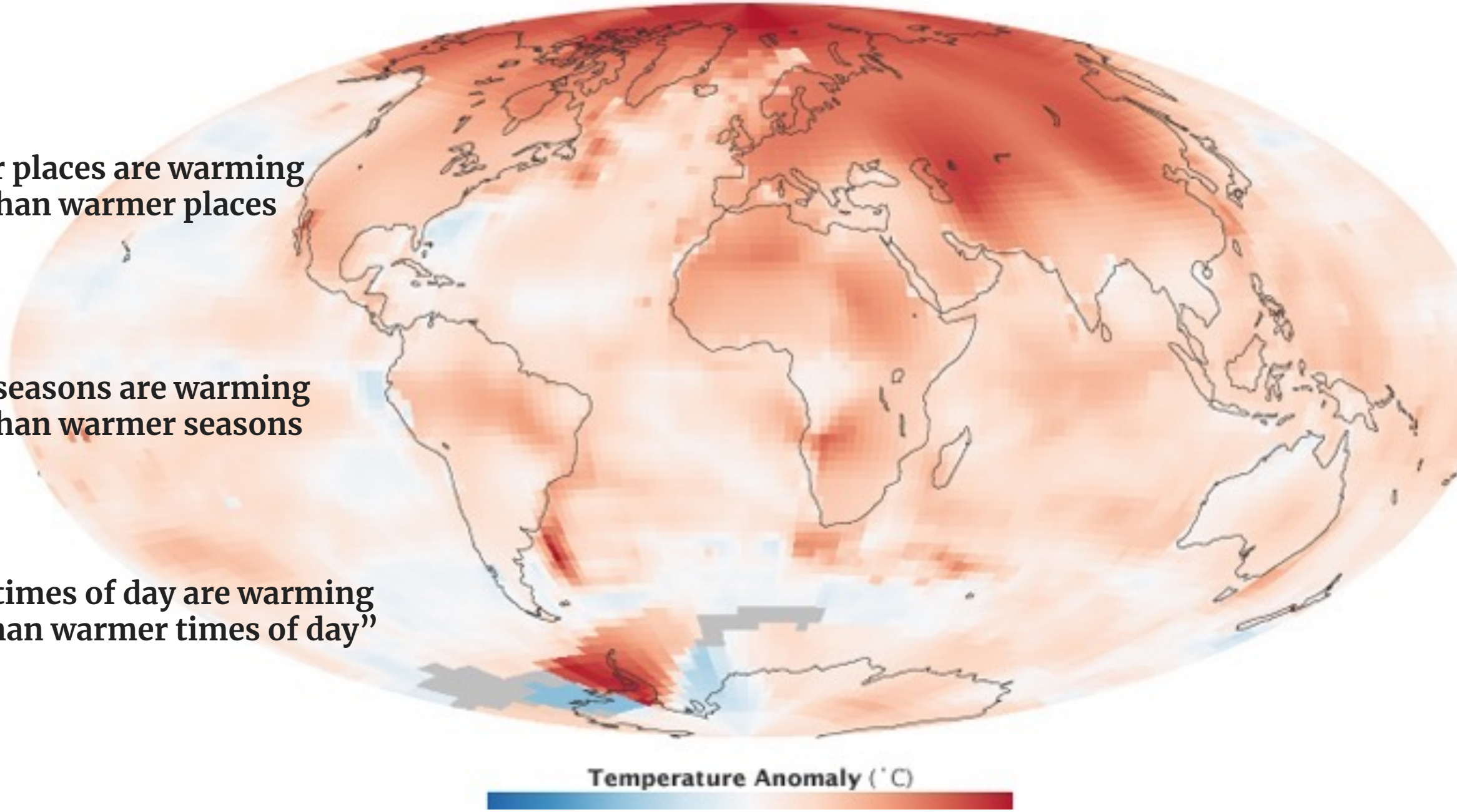


Sources: "Global, regional, and national burden of mortality associated with non-optimal ambient temperatures from 2000 to 2019", Lancet July 2021, https://www.thelancet.com /journals/lanplh/article/PIIS2542-5196(21)00081-4/fulltext, avoided deaths calculated using average of 2016-19 total deaths of 55.4m, http://ihmeuw.org/5iyx. twitter.com/bjornlomborg

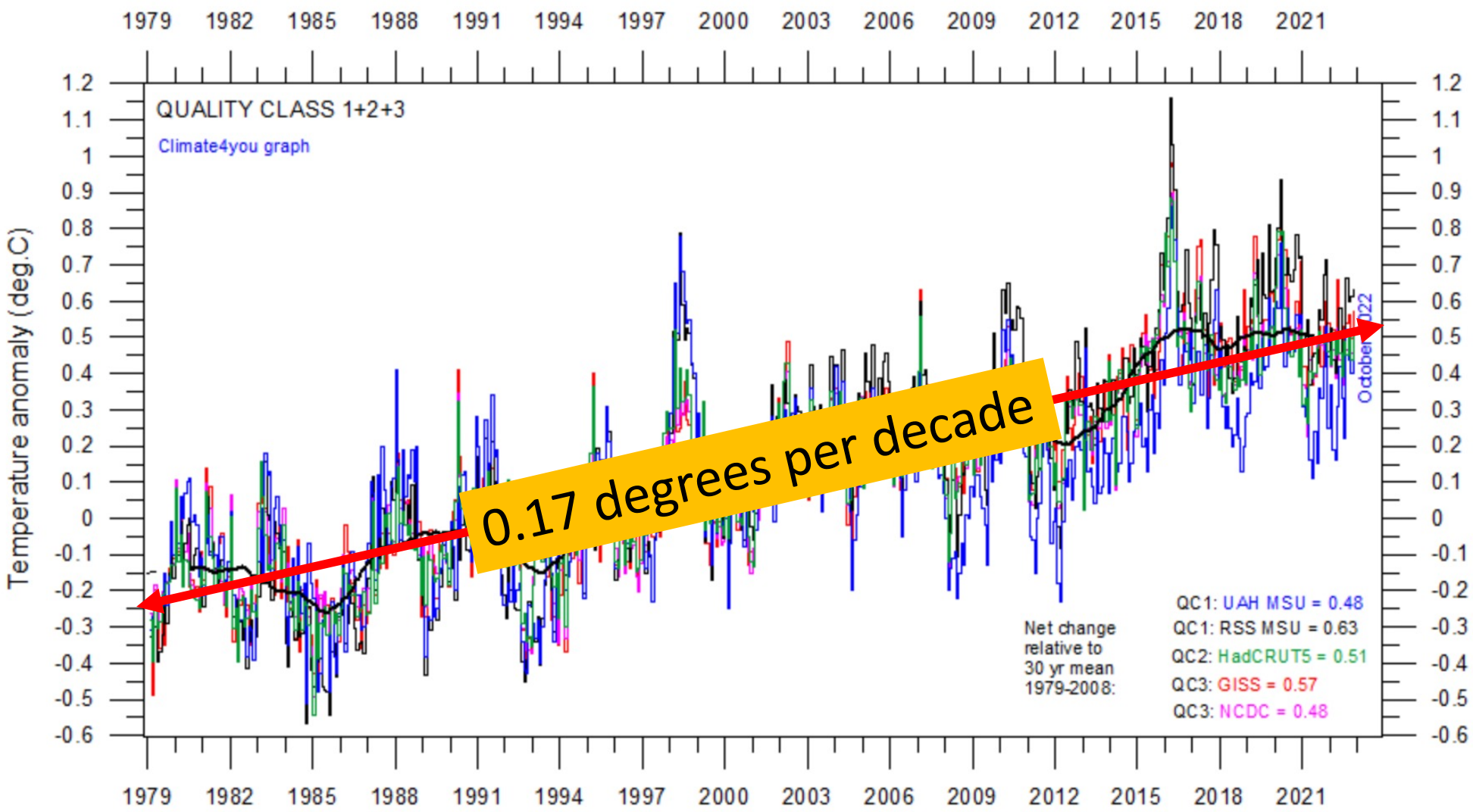
“Colder places are warming faster than warmer places

Colder seasons are warming faster than warmer seasons

Colder times of day are warming more than warmer times of day”



https://www.climate.gov/news-features/blogs/beyond-data/climate-change-rule-thumb-cold-things-warming-faster-warm-things



Superimposed plot of Quality Class 1 and Quality Class 2 and Quality Class 3 global monthly temperature estimates. As the base period differs for the different temperature estimates, they have all been normalised by comparing to the average value of 30 years from January 1979 to December 2008. The heavy black line represents the simple running 37 month (c. 3 year) mean of the average of all five temperature records. The numbers shown in the lower right corner represent the temperature anomaly relative to the above average. Values are rounded off to the nearest two decimals, even though some of the original data series come with more than two decimals. Last month shown: October 2022. Last diagram update: 13 December 2022.

Based on current model results, we predict:

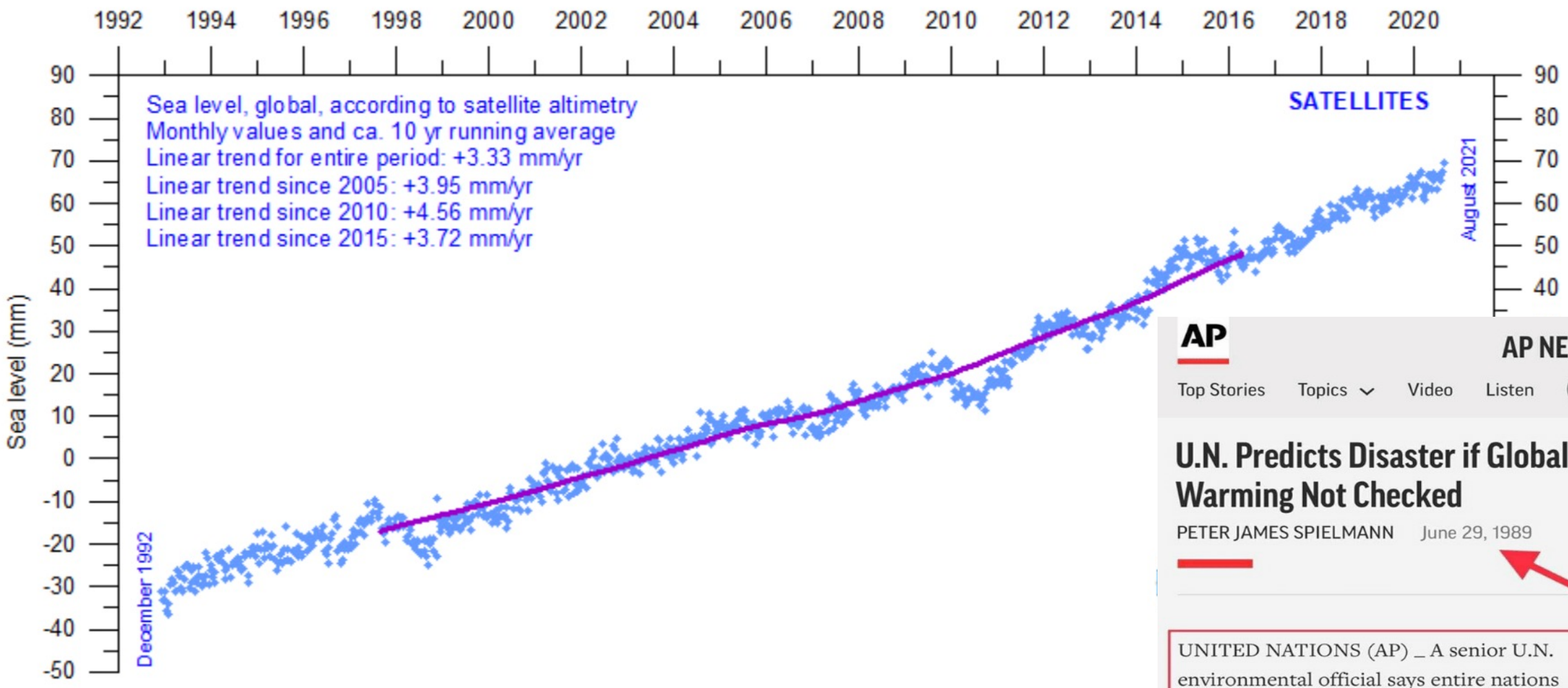
- under the IPCC Business-as-Usual (Scenario A) emissions of greenhouse gases, a rate of increase of global mean temperature during the next century of about 0 3°C per decade (with an uncertainty range of 0 2°C to 0 5°C per decade), this is greater than that seen over the past 10,000 years This will result in a likely increase in global mean temperature of about 1°C above the present value by 2025 and 3°C before the end of the next century The rise will not be steady because of the influence of other factors

IPCC, FAR, 1990, Summary for Policymakers, p 1

“I looked at 73 climate models going back to 1979 and every single one predicted more warming than happened in the real world.”

Prof John Christy, University of Alabama, Huntsville

Sea level rise – 3-4 mm a year



AP AP NEWS

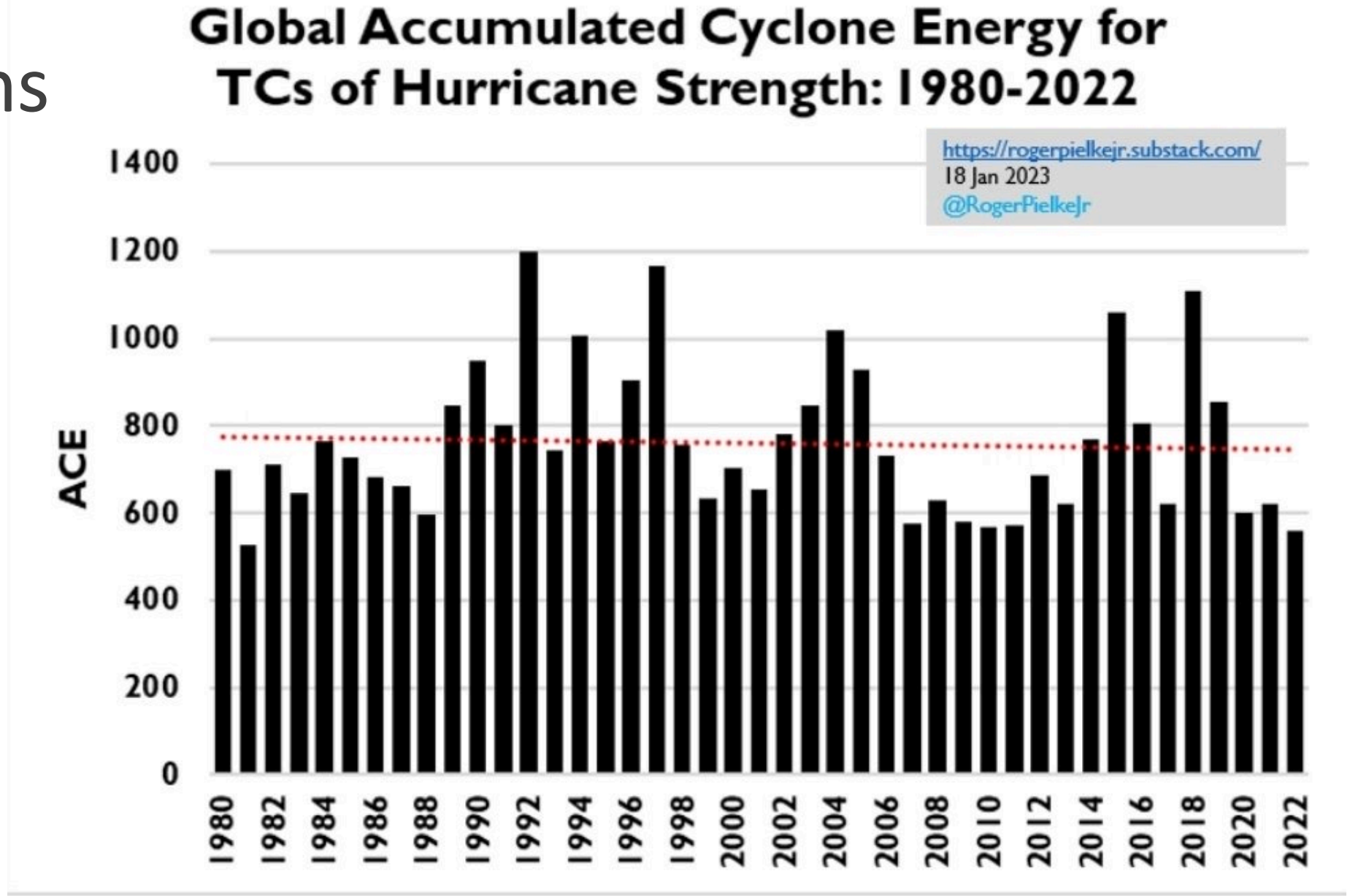
Top Stories Topics Video Listen

U.N. Predicts Disaster if Global Warming Not Checked

PETER JAMES SPIELMANN June 29, 1989

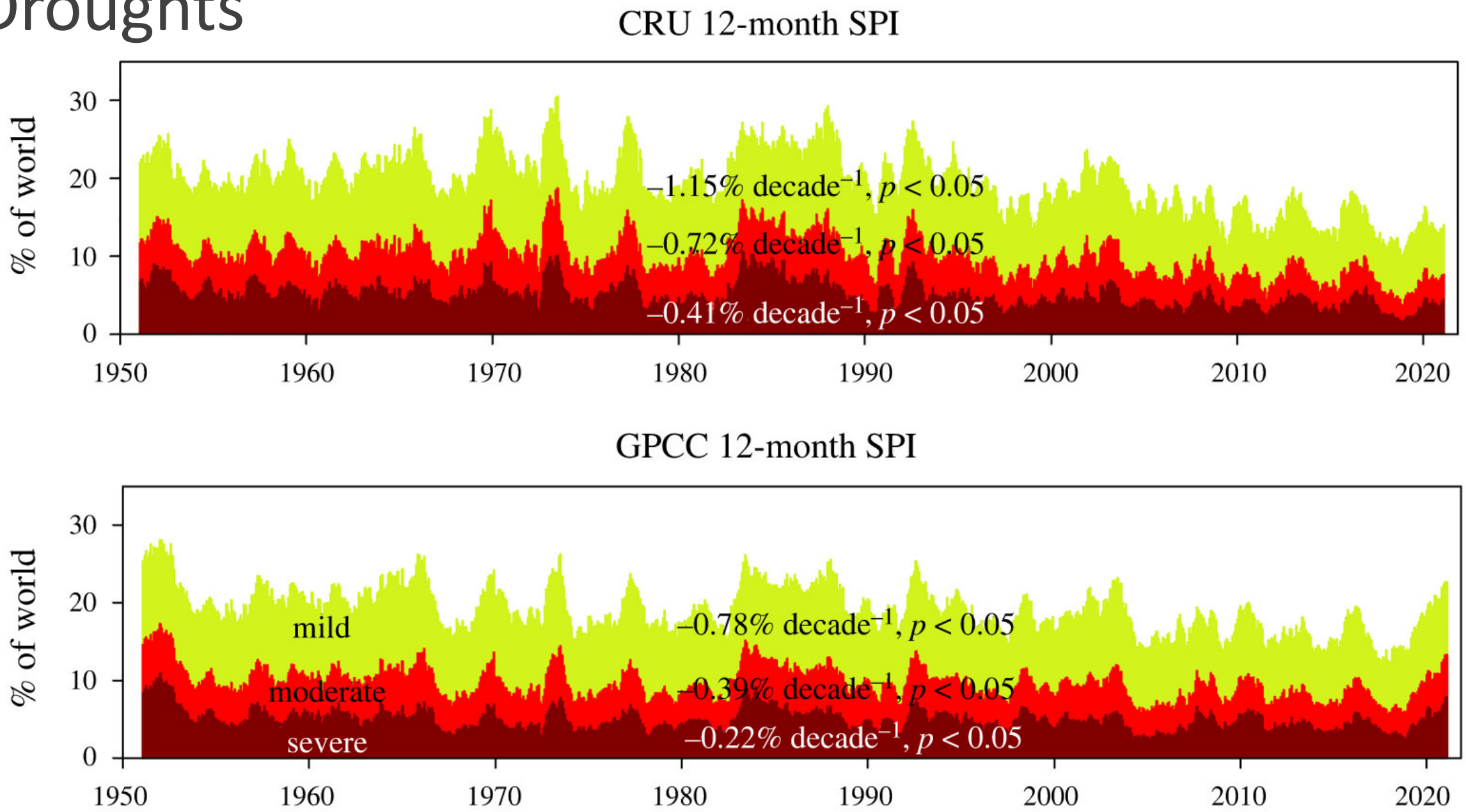
UNITED NATIONS (AP) _ A senior U.N. environmental official says entire nations could be wiped off the face of the Earth by rising sea levels if the global warming trend is not reversed by the year 2000.

Storms



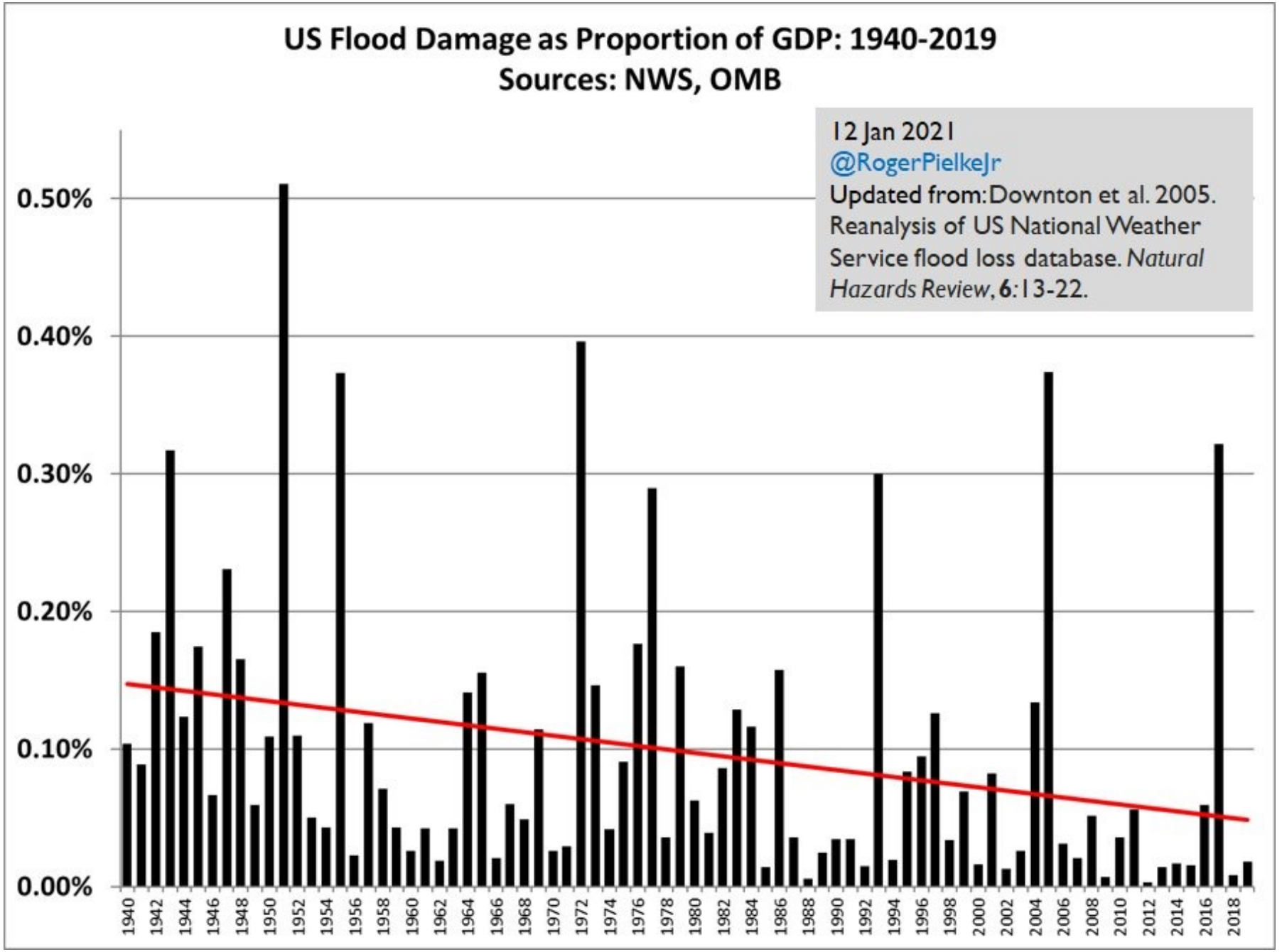
Global ACE, Source: CSU

Droughts



https://royalsocietypublishing.org/doi/10.1098/rsta.2021.0285

Floods


US Flood Damage as Proportion of GDP: 1940-2019
Sources: NWS, OMB
12 Jan 2021
@RogerPielkeJr
Updated from: Downton et al. 2005. Reanalysis of US National Weather Service flood loss database. Natural Hazards Review, 6:13-22.
0.50%
0.40%
0.30%
0.20%
0.10%
0.00%
1940
1942
1944
1946
1948
1950
1952
1954
1956
1958
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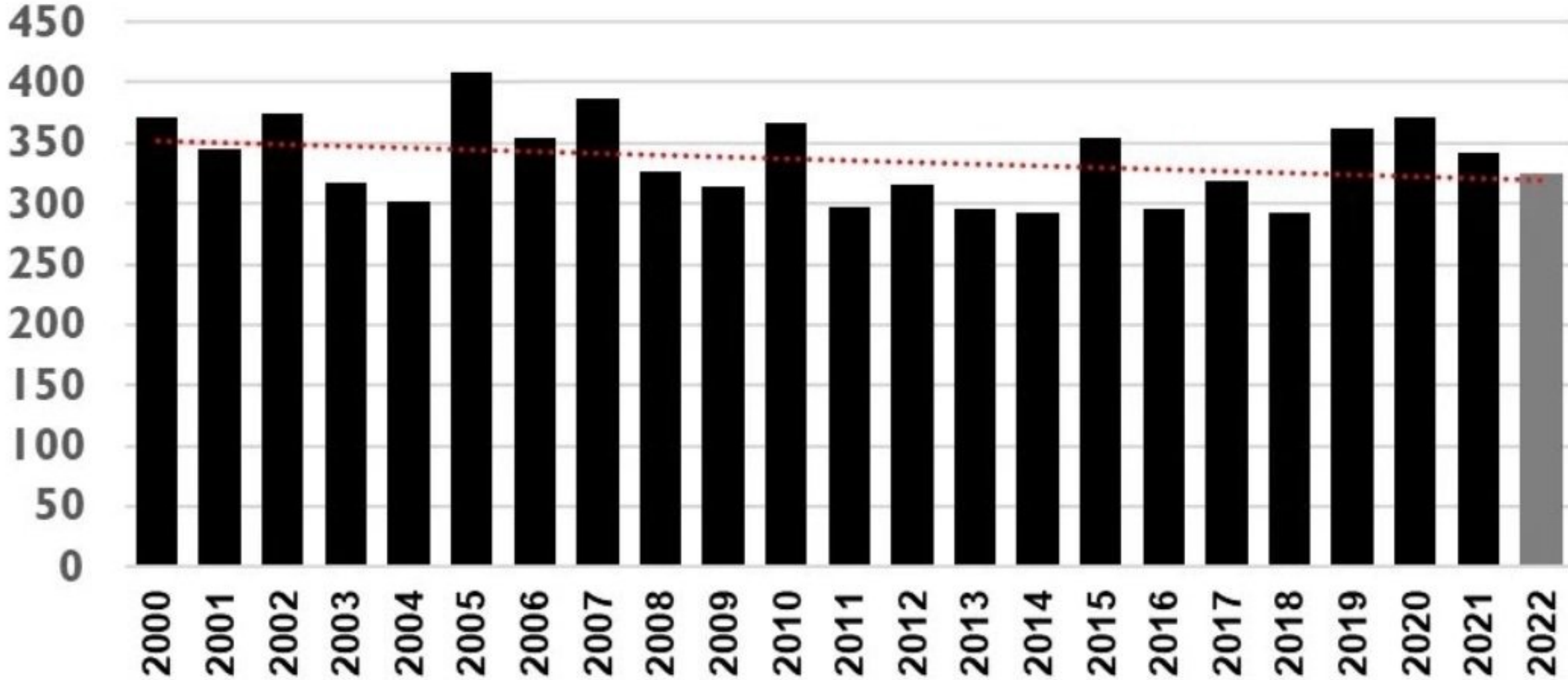
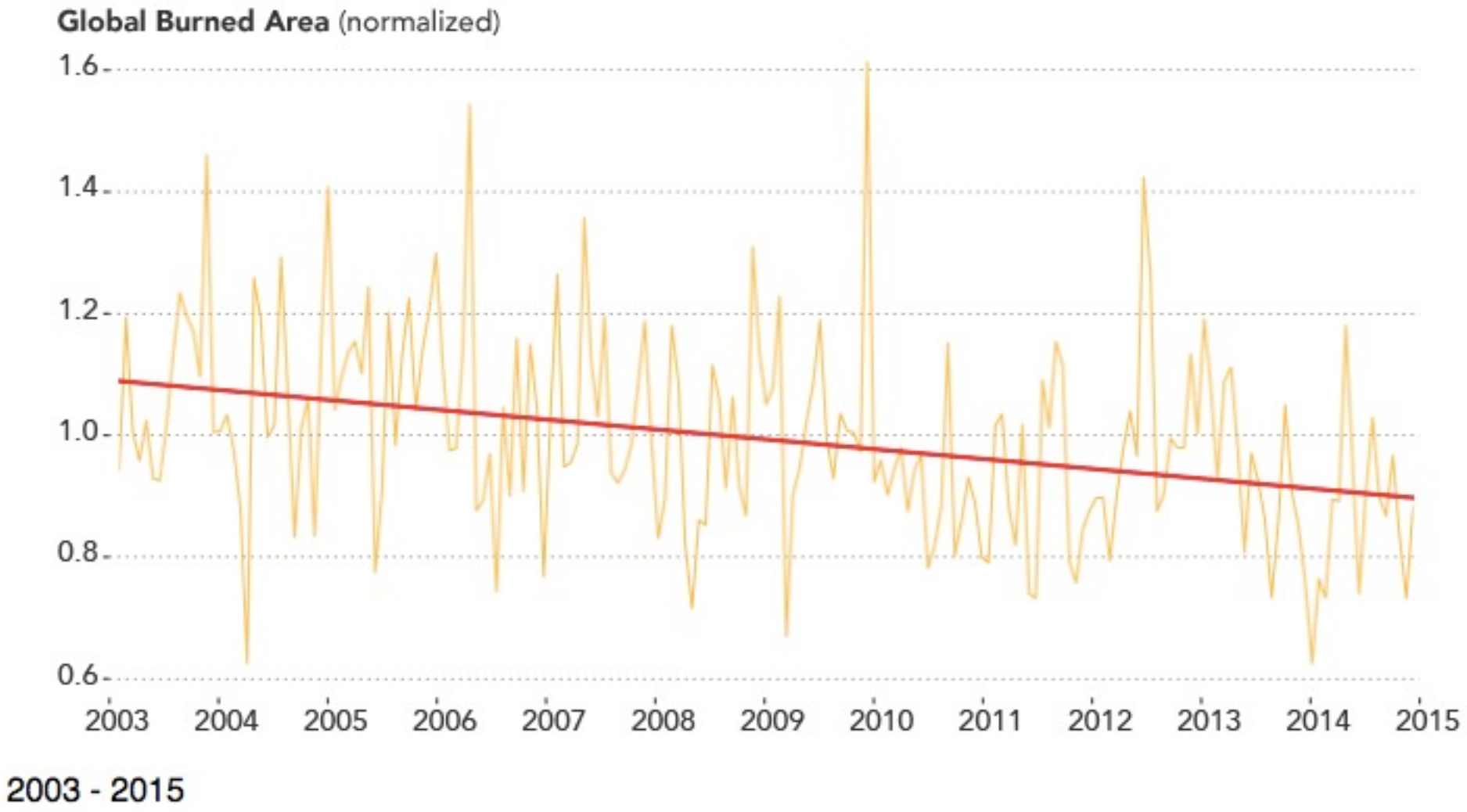
2008
2010
2012
2014
2016
2018

Global Weather and Climate Disasters 2000 to 2022

Source: CRED EM-DAT Hydrological, Climatologial, Meterological Disasters, 2022 = full year estimate based on Jan-Nov data



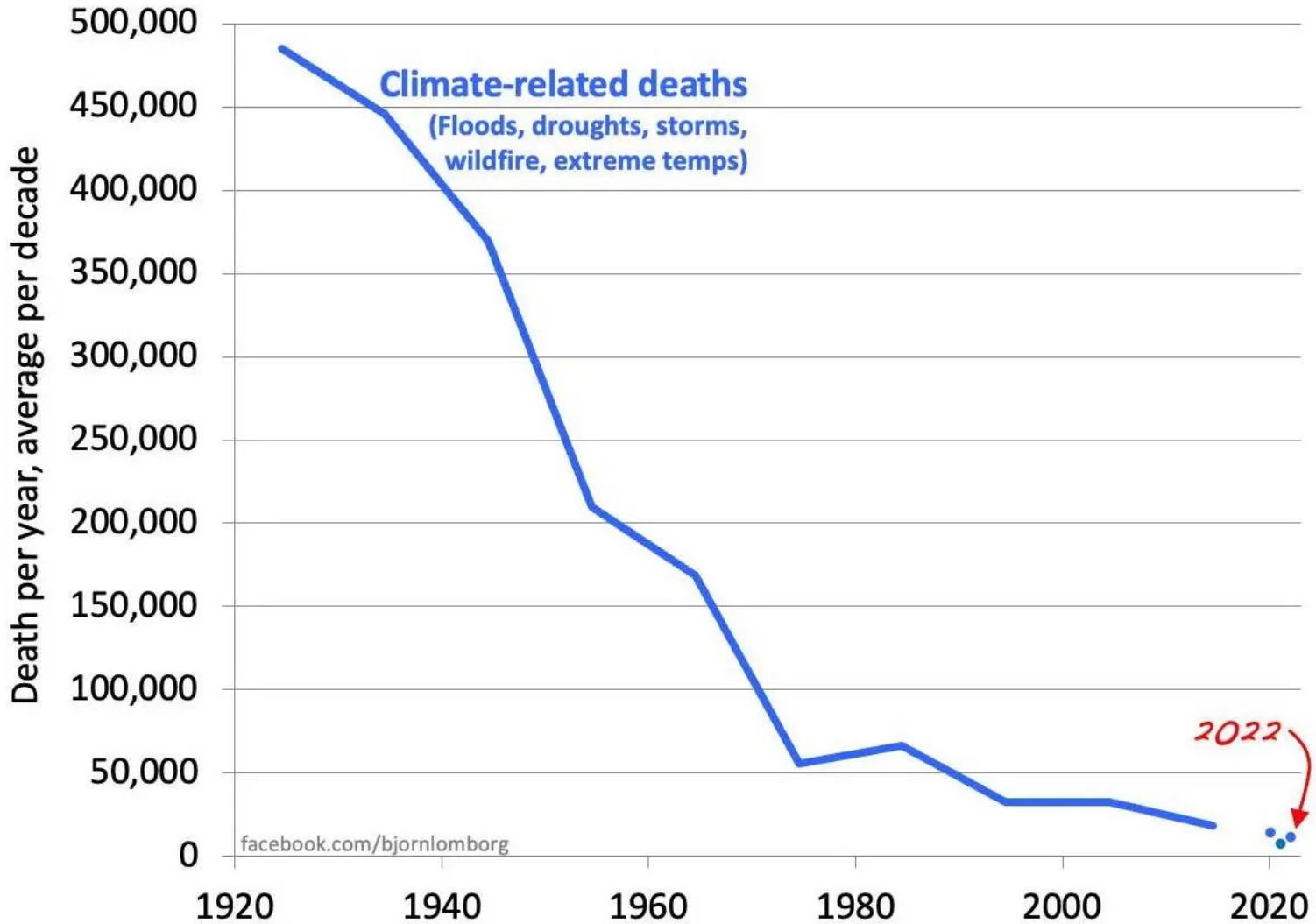
Fires



https://earthobservatory.nasa.gov/images/145421/building-a-long-term-record-of-fire

Climate-related Deaths: 1920-2022

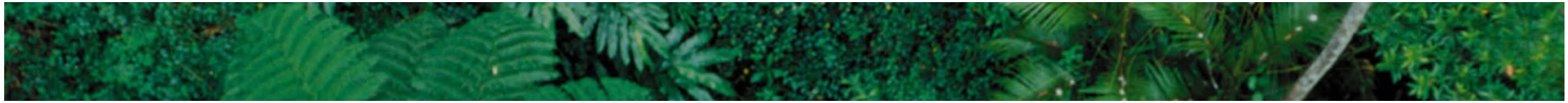
Deaths have declined precipitously because richer and more resilient societies reduce disaster deaths and swamp any potential climate signal



OFDA/CRED International Disaster Database, https://public.emdat.be, deaths averaged over decades 1920-29, 1930-1939, ... 2010-2019 placed at decadal midpoints (1924.5, 1934.5 etc), with annual data for 2020, 2021, and 2022, accessed January 1, 2023. Likely database will be updated further, so the current 2022 estimate is probably low. 2022 at 14,920 dead, 2021: 7,705, 2022: 11,873. Update of Fig. 17 from https://www.sciencedirect.com/science/article/pii/S0040162520304157.

“Models used to influence policy on climate change have

- overestimated the rate of warming,
- underestimated direct benefits of carbon dioxide,
- overestimated the harms from climate change and
- underestimated human capacity to adapt so as to capture the benefits while reducing the harms.”



https://www.thegwpf.org/content/uploads/2015/10/benefits1.pdf

Is decarbonization hurting the poor?

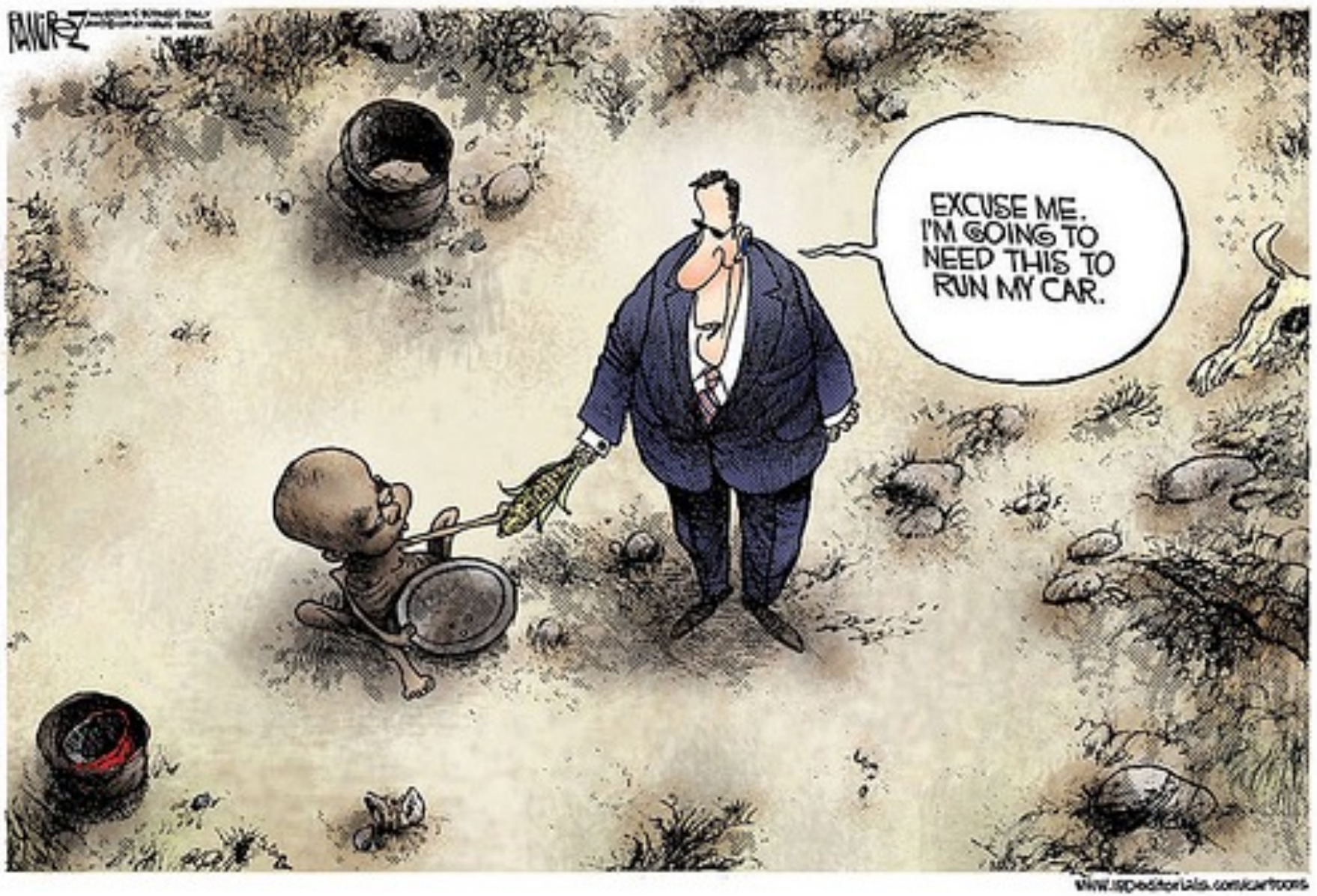
- Renewable energy subsidies captured by the wealthy
- Energy cost as a proportion of income highest among the poor
- Today's poor carrying the cost of the energy transition to benefit tomorrow's wealthy
- A billion people without electricity now refused fossil fuel subsidies
- 3 million deaths from indoor air pollution, caused by cooking over wood and dung

Half A Million Lives Could Be Saved Yearly By Replacing Wood And Charcoal Stoves In Africa

January 13, 2023 Eurasia Review 0 Comments

By Eurasia Review

Turning food into fuel



Michael Ramirez

Costs and benefits, trade-offs and opportunity costs…

Costs

- Rising sea level – very slow
- Longer heat waves - yes
- Worse floods – no
- More severe droughts - no
- More frequent storms - no
- More forest fires - no
- Ocean acidification - no

Benefits

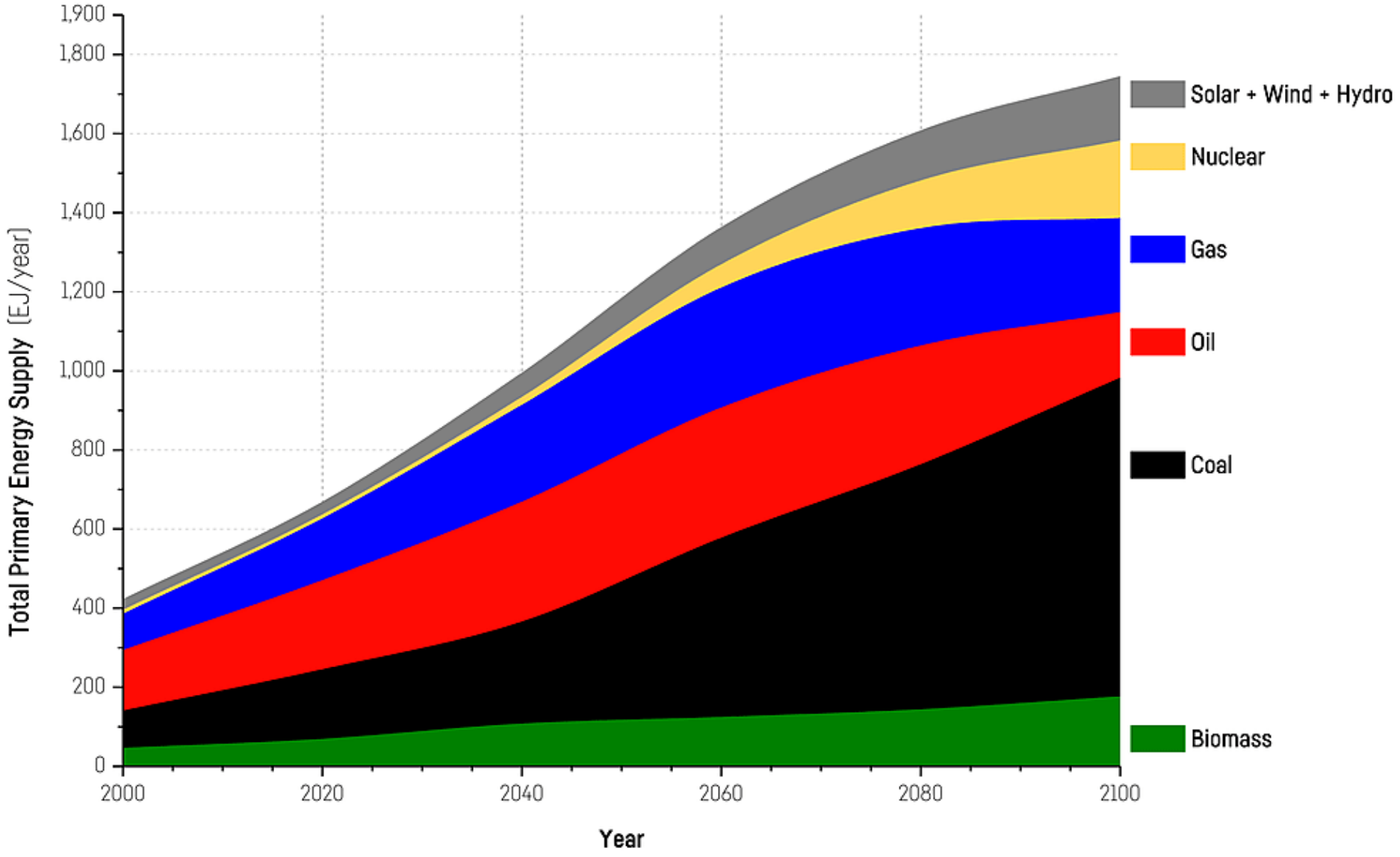
- Global greening - yes
- Ocean productivity - yes
- Water use efficiency - yes
- Higher yields/land sparing – yes
- Reduced cold deaths – yes
- Longer growing seasons – yes
- [Avoided decarbonization] - huge

Ah, but what about Pascal's wager?

Energy contributions in RCP 8.5.

"The misuse of RCP 8.5 involves the transformation of what is more accurately described as a worst-case scenario into the sole "business as usual" or baseline scenario that has become a centerpiece of climate policy discussions."

Roger Pielke Jr



1. What is the social cost of carbon?

The short answer: The social cost of carbon is the cost of the damages created by one extra ton of carbon dioxide emissions.

Burke: When we emit a ton of carbon dioxide in the atmosphere, it sticks around for a while and causes warming, affecting human outcomes. The social cost of carbon is the total damage that an additional ton of CO_2 has on outcomes, converted into dollars.

[Back to the list of questions]

2. How is this cost calculated?

The short answer: When calculating the social cost of carbon, the main components are what happens to the climate and how these changes affect economic outcomes, including changes in agricultural productivity, damages caused by sea level rise, and decline in human health and labor productivity.

Goulder: The cost is usually

$51/ton

"Why did you abandon Social Cost of Carbon?" JC asked.

The ex DGE replied: "Oh, it was embarrassing. You see we couldn't find a mitigation policy with an abatement cost even close to the Social Cost, let alone below it."

Research Article | Open Access | Published: 18 January 2020

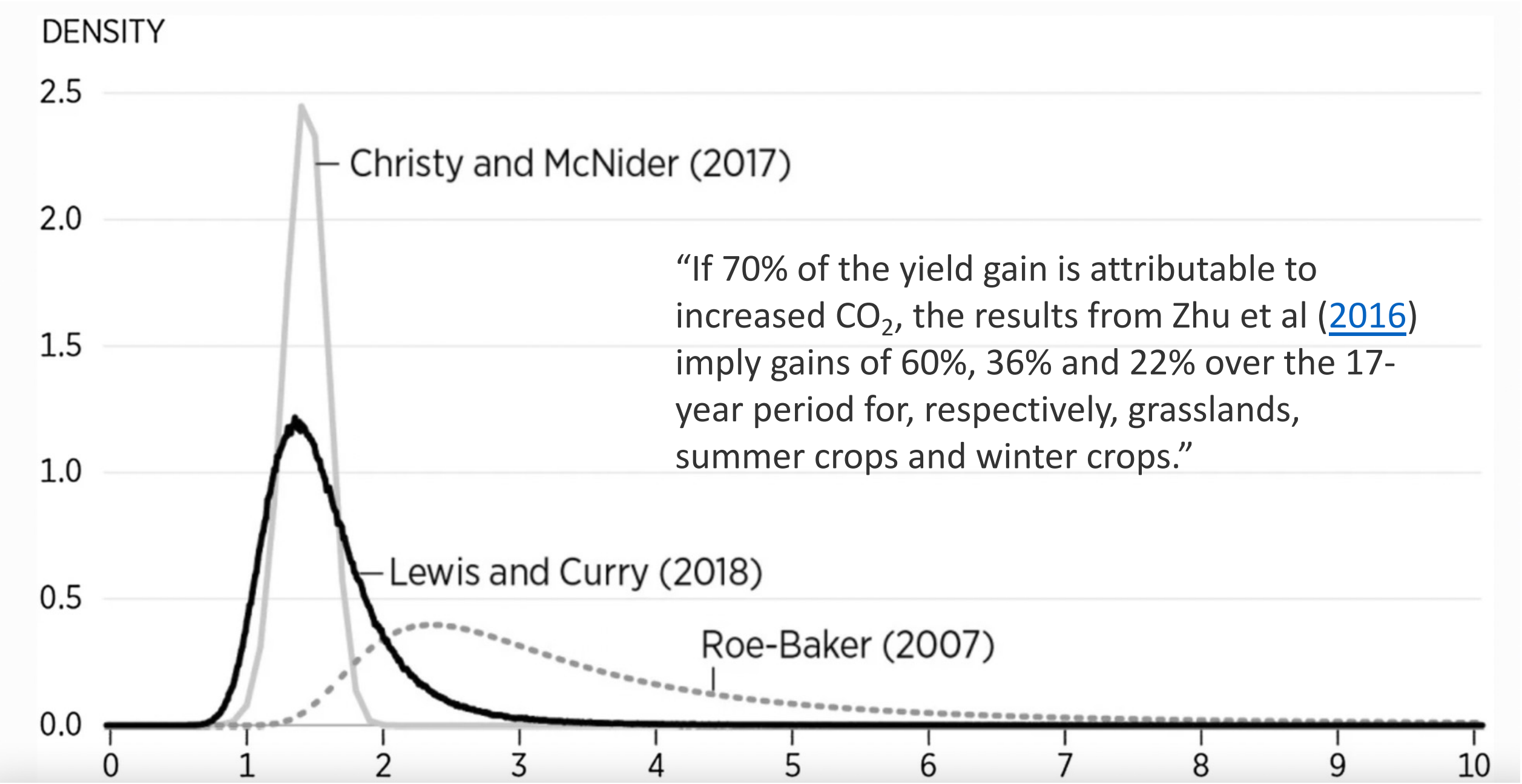
Climate sensitivity, agricultural productivity and the social cost of carbon in FUND

Kevin D. Dayaratna, Ross McKitrick ✉ & Patrick J. Michaels

Environmental Economics and Policy Studies **22**, 433–448 (2020) | Cite this article

"If 70% of the yield gain is attributable to increased CO_2, the results from Zhu et al (2016) imply gains of 60%, 36% and 22% over the 17-year period for, respectively, grasslands, summer crops and winter crops."

- Models vastly understate CO2 fertilization effect
- Models understate adaptation
- Models overstate climate sensitivity
- Models use very low discount rates



"If 70% of the yield gain is attributable to increased CO_2, the results from Zhu et al (2016) imply gains of 60%, 36% and 22% over the 17-year period for, respectively, grasslands, summer crops and winter crops."

https://link.springer.com/article/10.1007/s10018-020-00263-w

Table 3 Mean social cost of carbon in FUND model using Christy and McNider (2017) ECS distribution and original agricultural CO_2 fertilization parameter (Ag + 0% column), then with CO_2 fertilization parameter increased by 15% and 30% (Ag + 15%, Ag + 30%, respectively)

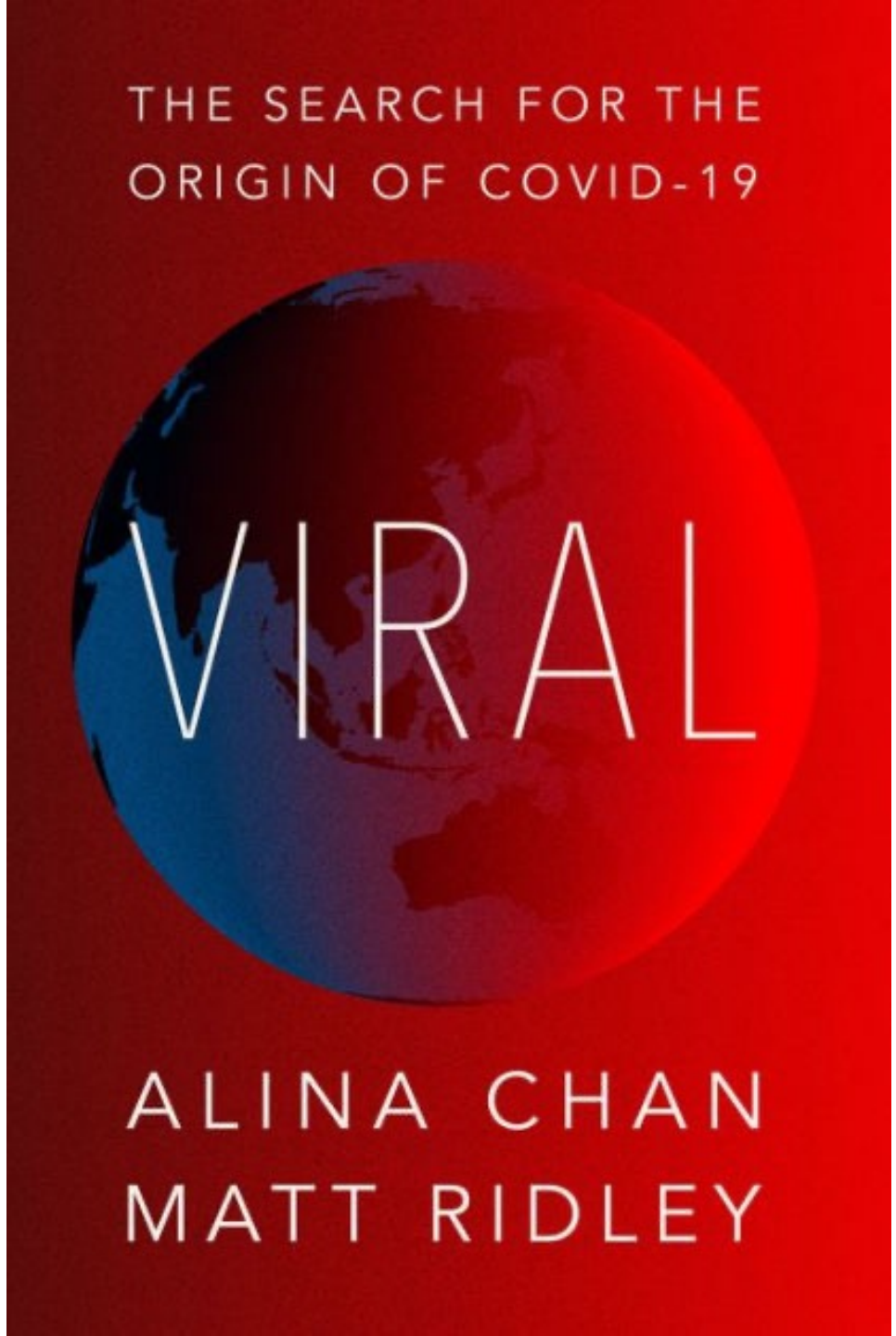
From: Climate sensitivity, agricultural productivity and the social cost of carbon in FUND

Year	Christy–McNider distribution, 3.0% discount rate		
	Ag+0%	Ag+15%	Ag+30%
2020	−$1.34/0.58	−$3.50/0.66	−$5.73/0.72
2030	−$0.95/0.55	−$3.29/0.63	−$5.70/0.69
2040	−$0.40/0.52	−$2.90/0.60	[illegible]
2050	$0.32/0.48	−$2.33/0.56	−$5.06/0.62

Each entry shows the SCC estimate and the associated probability of a negative SCC

All but one of these numbers is negative!

The end



ALINA CHAN
& MATT RIDLEY

VIRAL

The Search for the
Origin of Covid-19