Stakeholder Advisory Group

Board of Water Supply
City & County of Honolulu

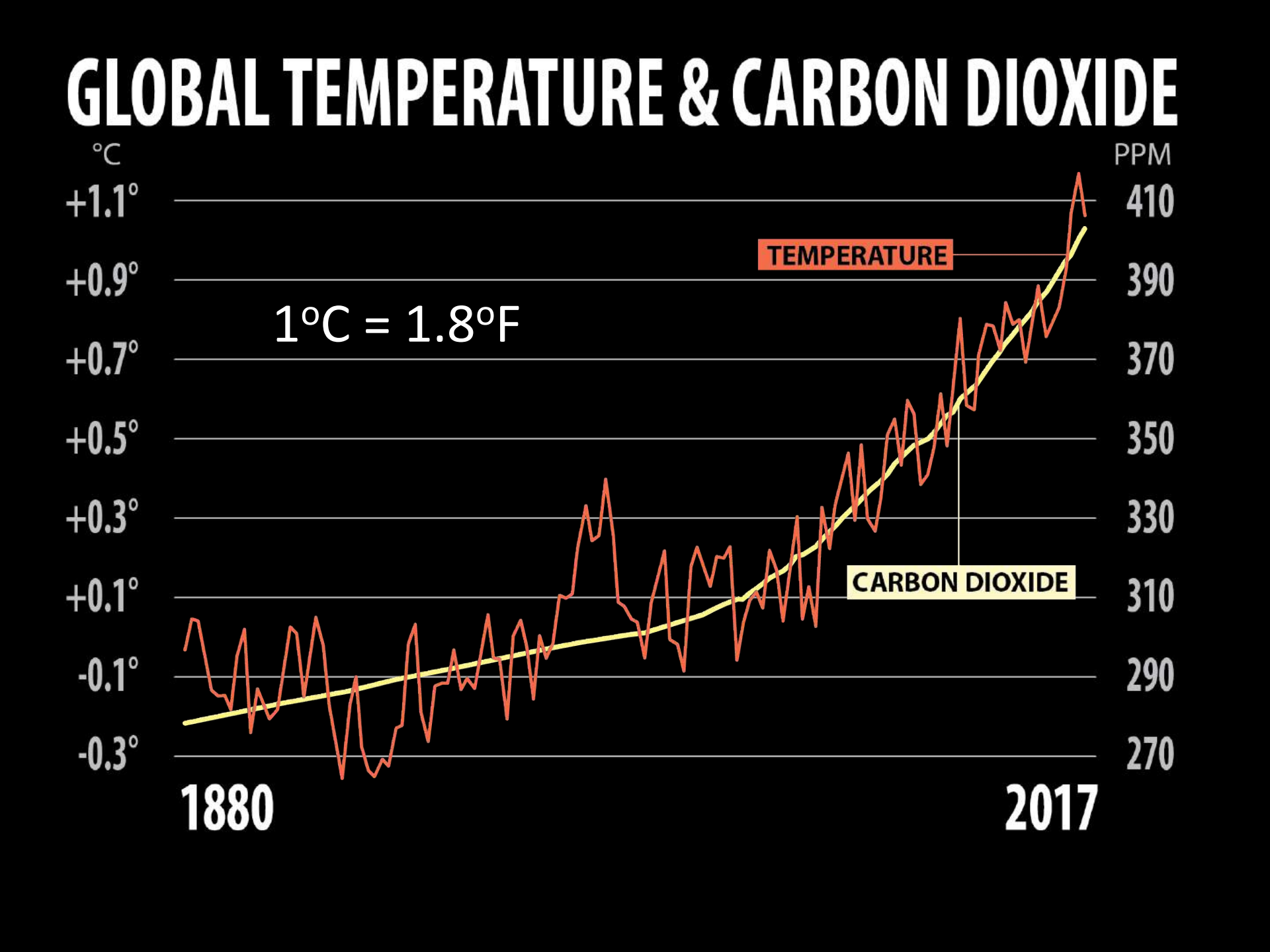
Thursday April 25, 2019

Dr. Charles H. Fletcher, III (Chip)

Associate Dean for Academic Affairs and Professor of Earth Sciences
School of Ocean and Earth Science and Technology (SOEST)
University of Hawai‘i at Mānoa
Vice-Chair of the Honolulu Climate Change Commission

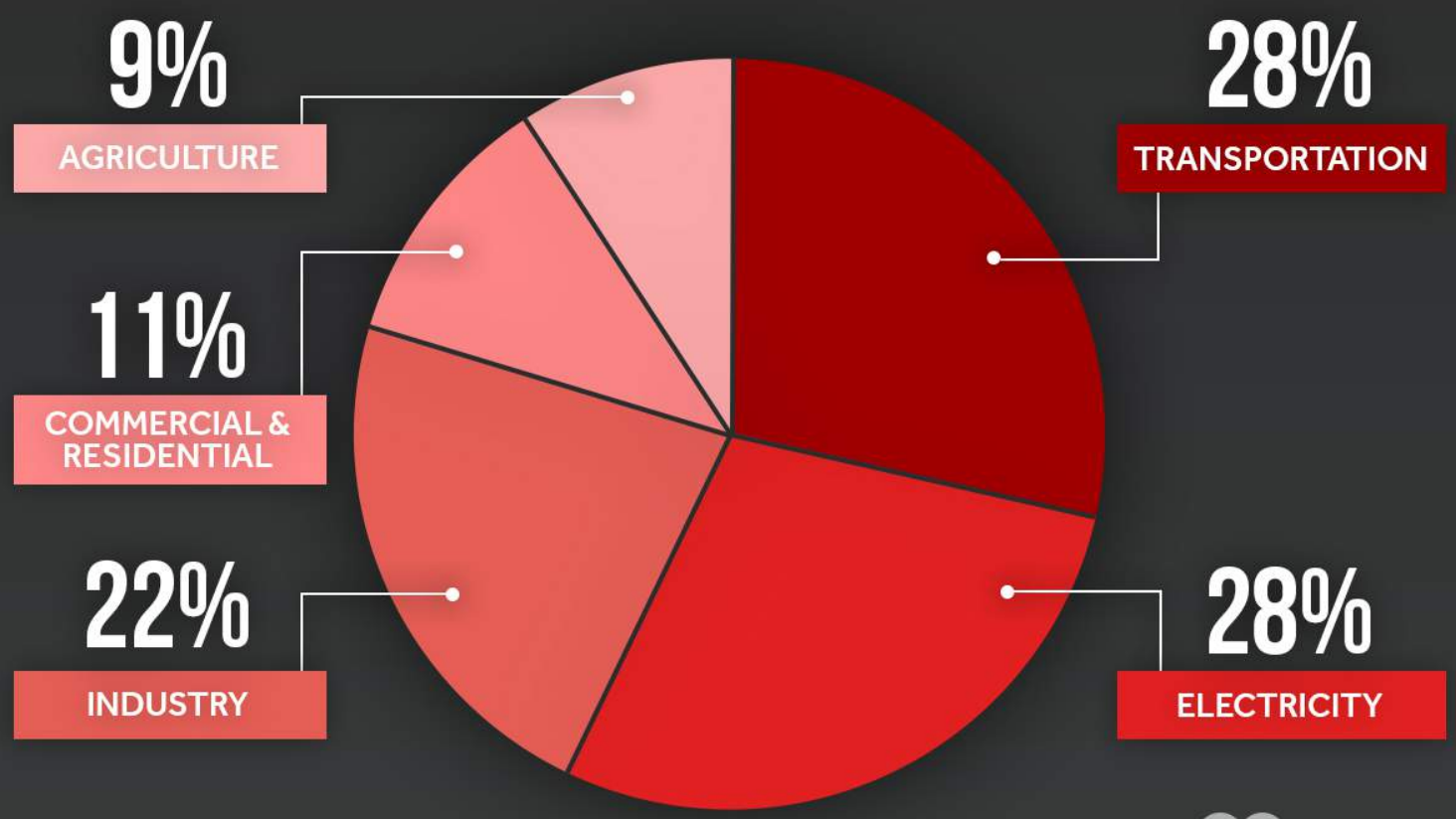
CLIMATE CHANGE PANEL DISCUSSION


We have 10
years to cut
emissions
by 50%


GLOBAL TEMPERATURE & CARBON DIOXIDE
°C
PPM
+1.1°
+0.9°
+0.7°
+0.5°
+0.3°
+0.1°
-0.1°
-0.3°
410
390
370
350
330
310
290
270
1°C = 1.8°F
TEMPERATURE
CARBON DIOXIDE
1880
2017

GREENHOUSE GAS SOURCES

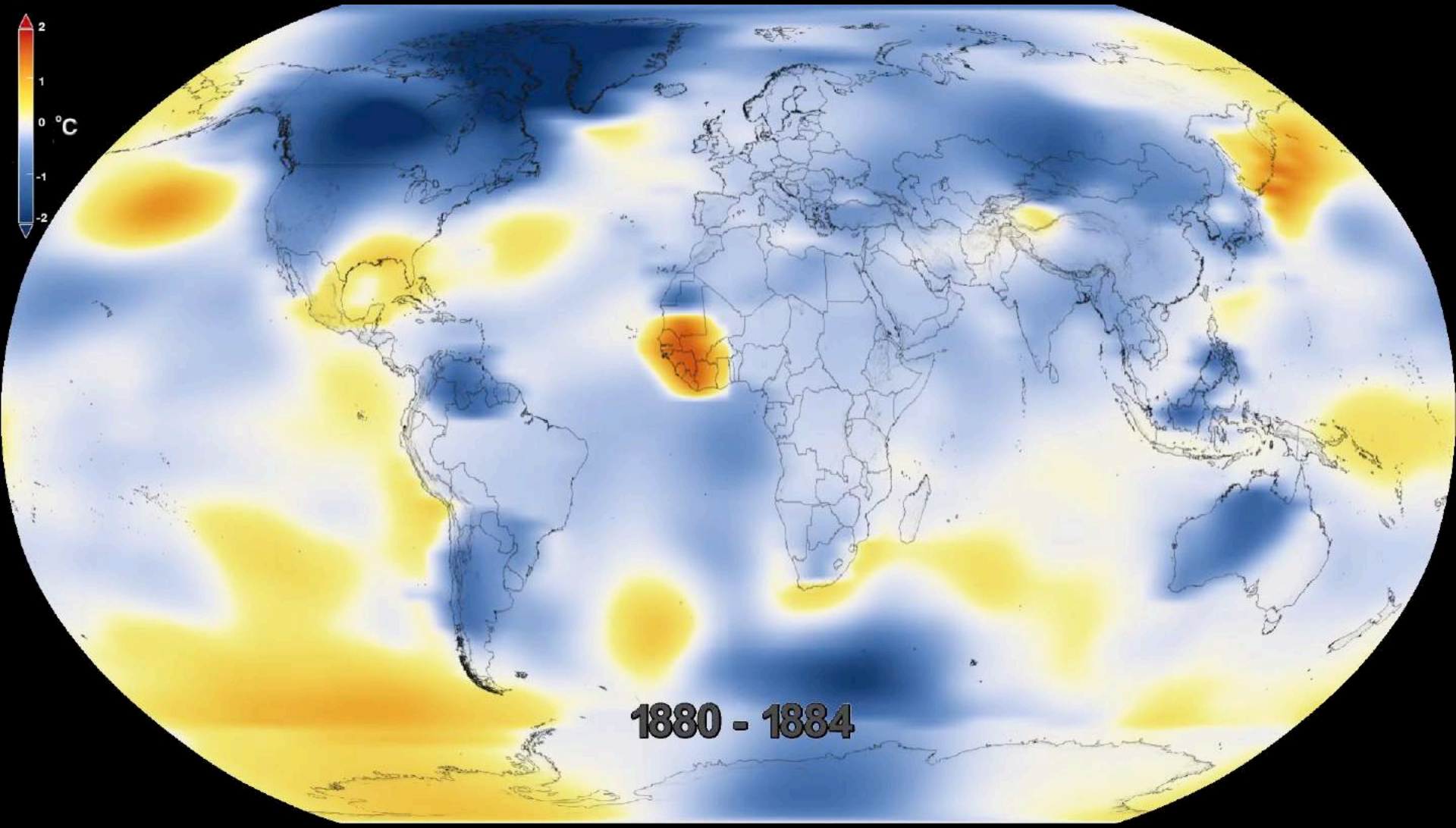
United States Greenhouse Gas Emissions by Sector



Source: US EPA

CLIMATE CENTRAL

The world is now 1°C (1.8°F) warmer



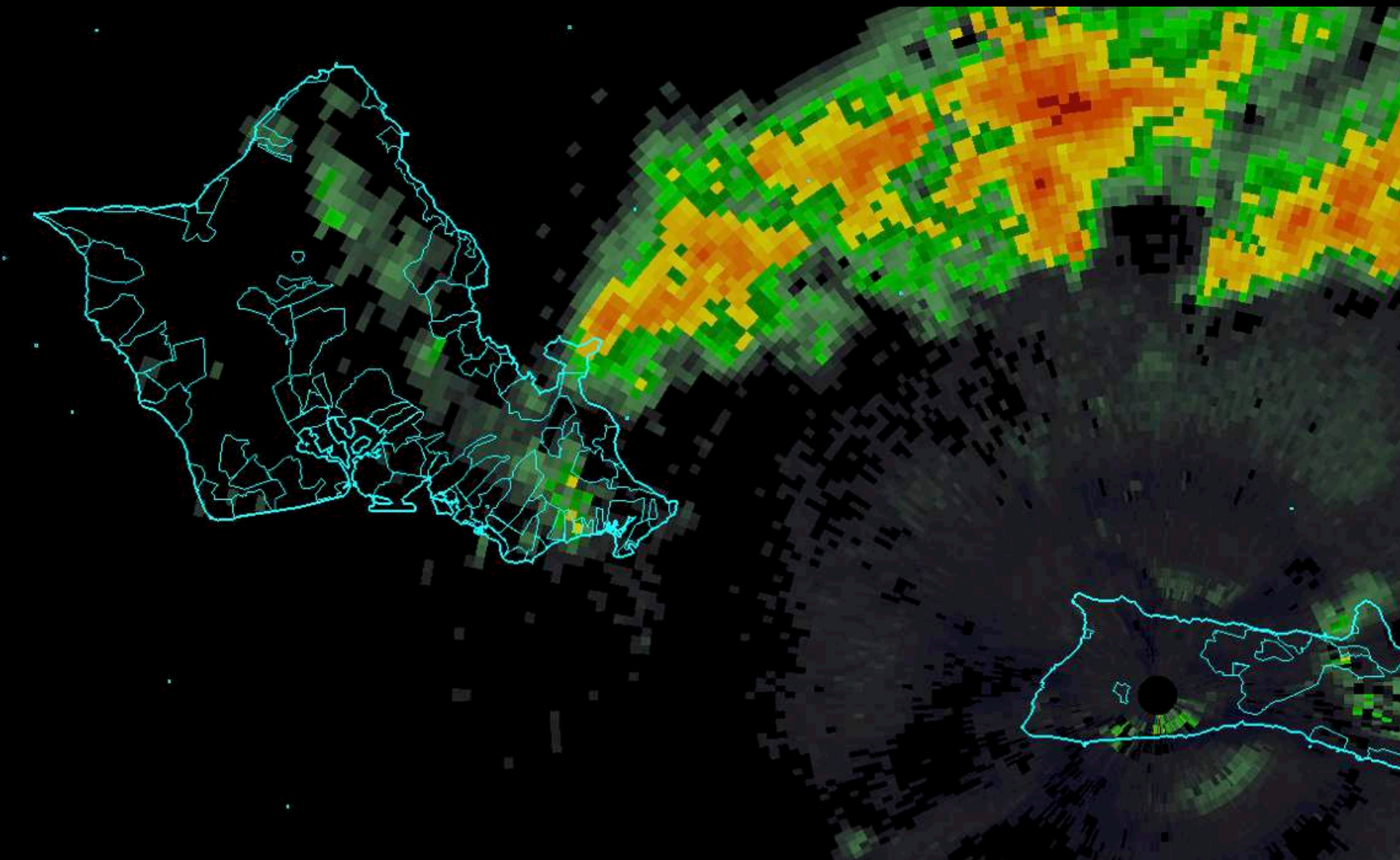
https://www.youtube.com/watch?v=Z4bSxb5THm4

Lehmann, J., et al. (2015) Increased record-breaking precipitation events under global warming, *Climatic Change*, doi: 10.1007/s10584-015-1434-y

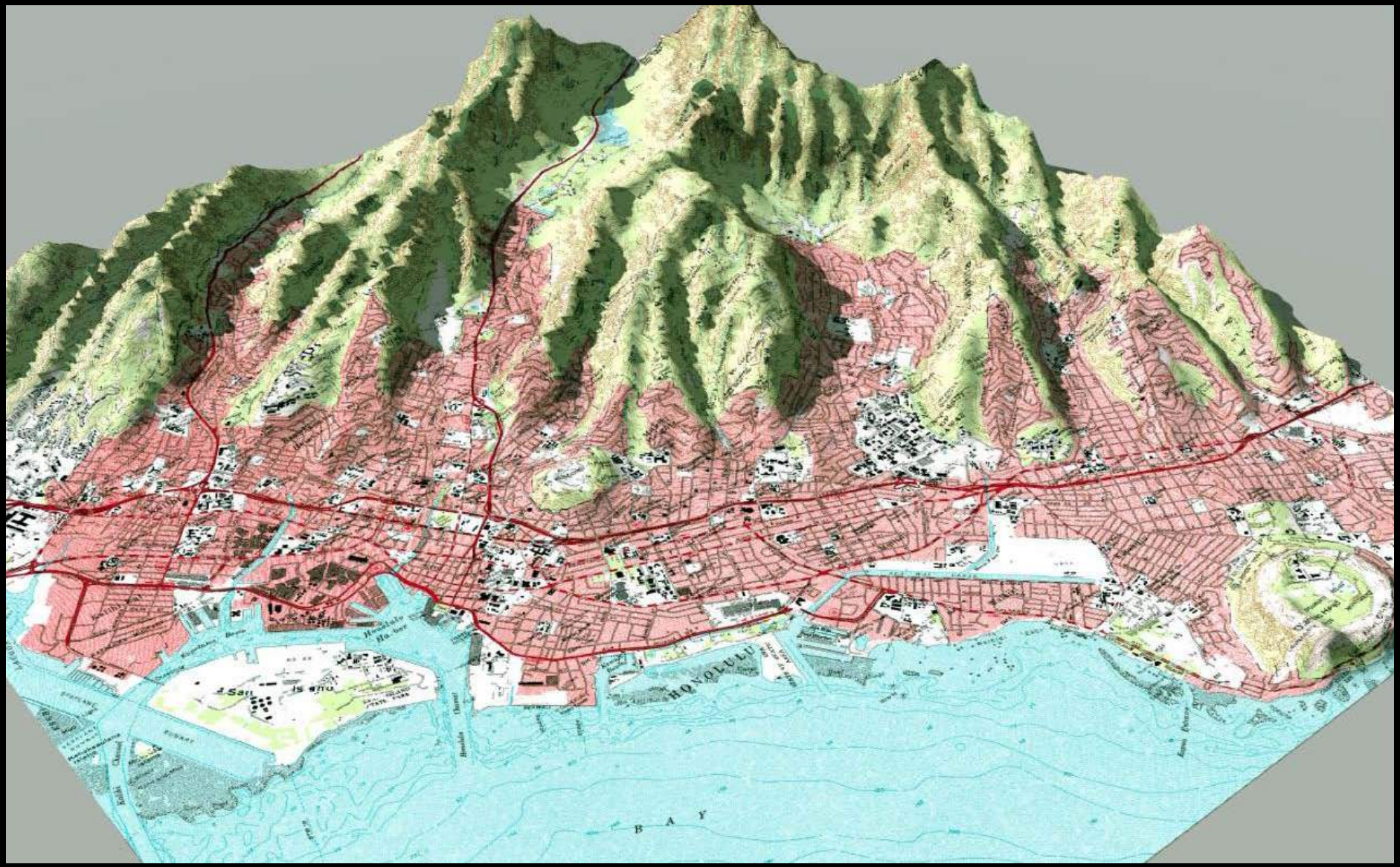
Extreme rainfall has increased 12%

Lehmann, J., et al. (2015) Increased record-breaking precipitation events under global warming, *Climatic Change*, doi: 10.1007/s10584-015-1434-y

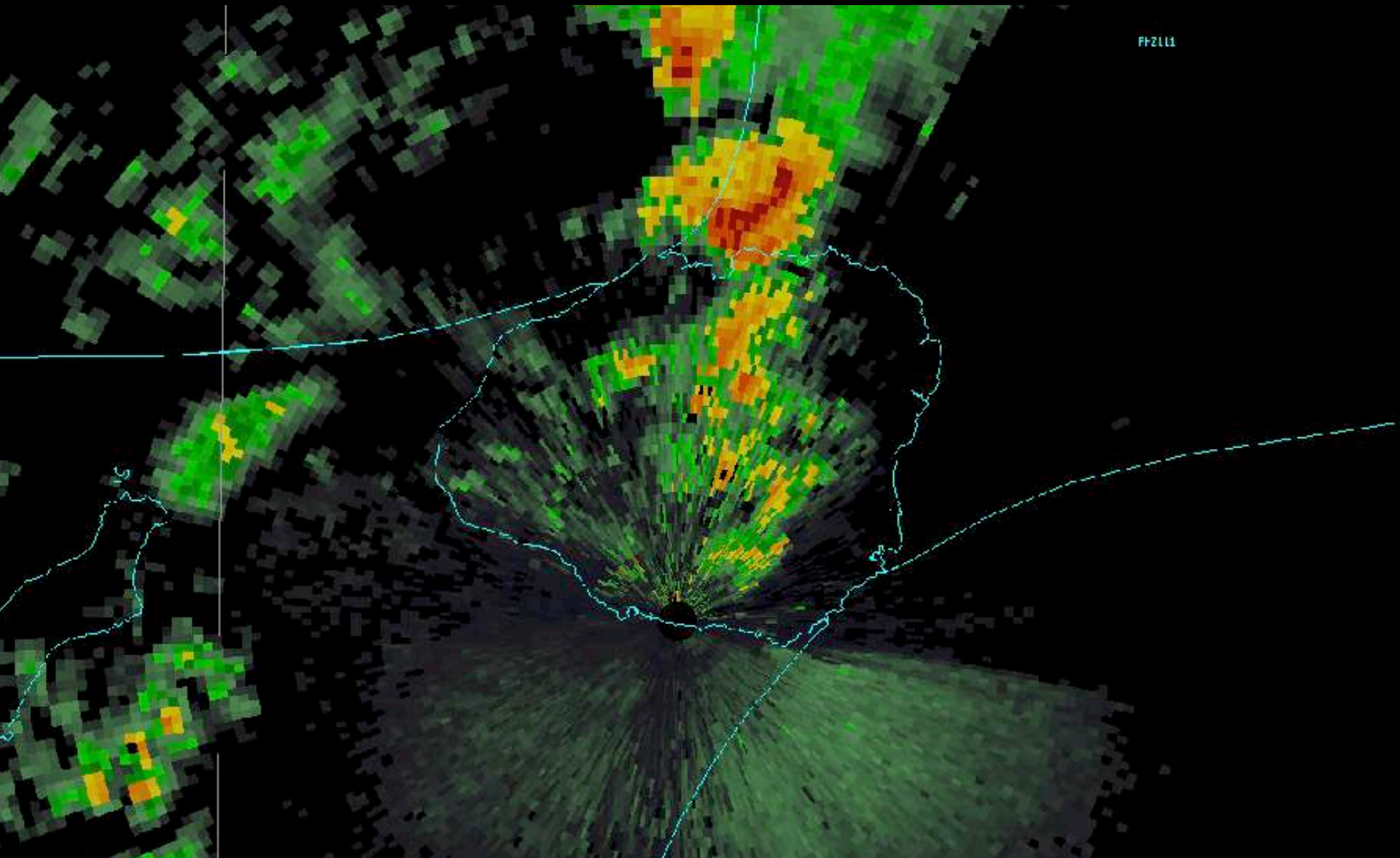
O‘ahu, April 2018
State of Emergency, $124 million



Short steep watersheds w/ heavy development promote flooding



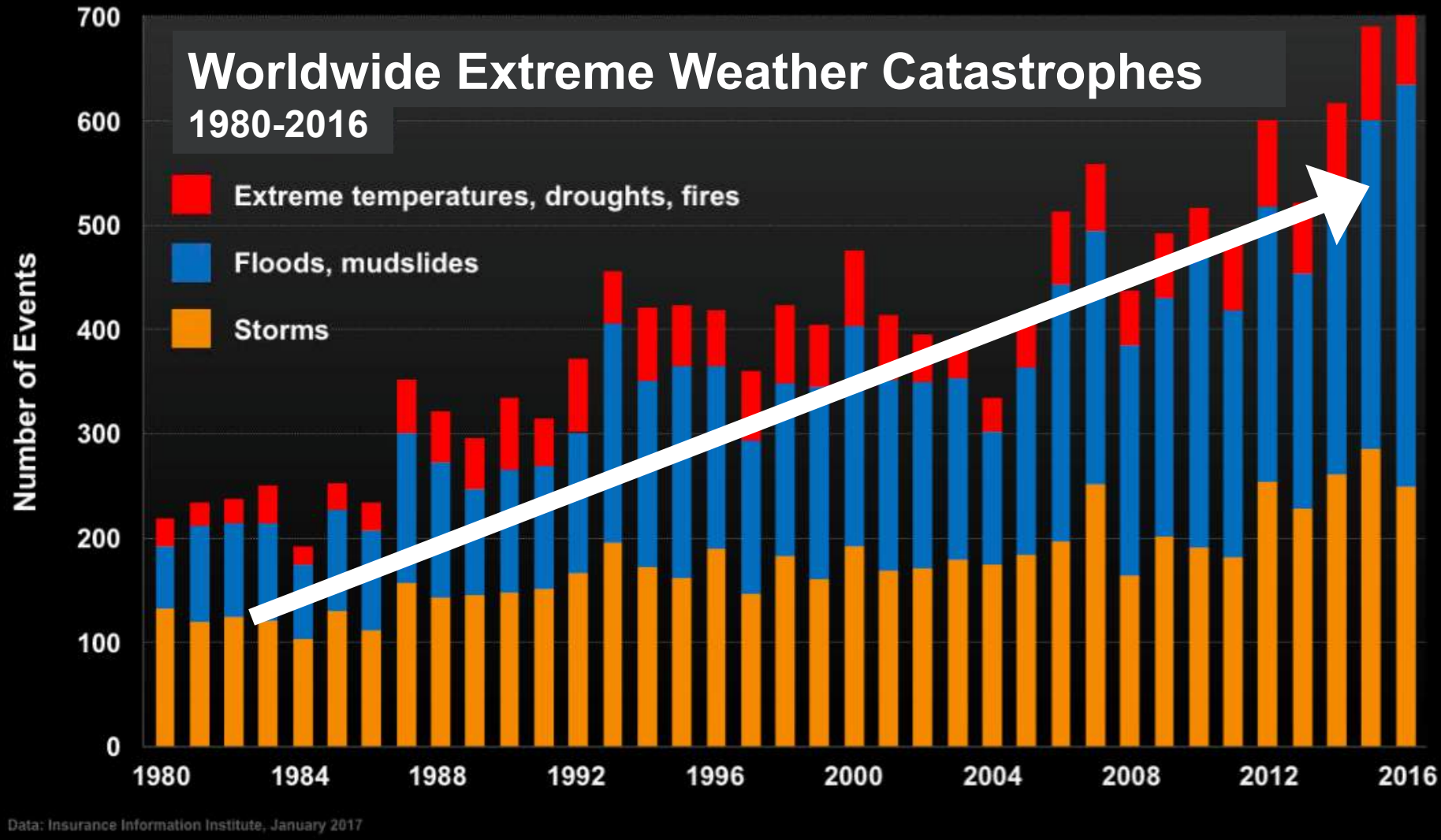
Kaua‘i, April 2018
49.69 inches of rainfall in a 24-hour period, national record




VOLVO

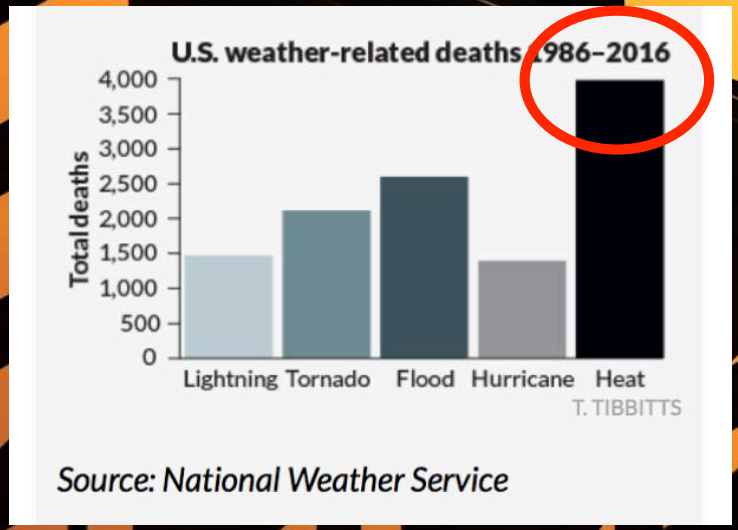
Weather disasters have doubled in two decades

Centre for Research on the Epidemiology of Disasters, UN International Strategy for Disaster Reduction: http://reliefweb.int/report/world/human-cost-weather-related-disasters-1995-2015


Worldwide Extreme Weather Catastrophes
1980-2016
Extreme temperatures, droughts, fires
Floods, mudslides
Storms
Number of Events
700
600
500
400
300
200
100
0
1980
1984
1988
1992
1996
2000
2004
2008
2012
2016
Data: Insurance Information Institute, January 2017

Kitzberger T, et al.(2017) Direct and indirect climate controls predict heterogeneous early-mid 21st century wildfire burned area across western and boreal North America. PLoS ONE 12(12). https://doi.org/10.1371/journal.pone.0188486
Abatzoglou, J.T., Williams, A.P. (2016) Impact of anthropogenic climate change on wildfire across western U.S. forests. *Proceedings of the National Academy of Sciences*; 201607171 doi: 10.1073/pnas.1607171113

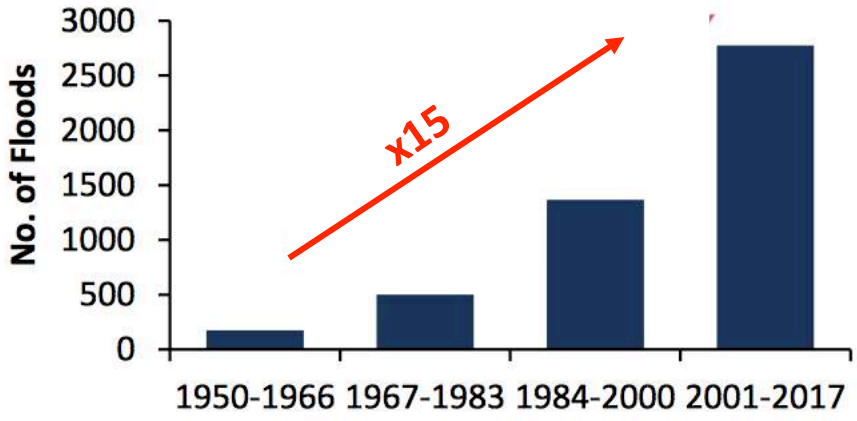
Heat waves are the deadliest natural disaster in the U.S.



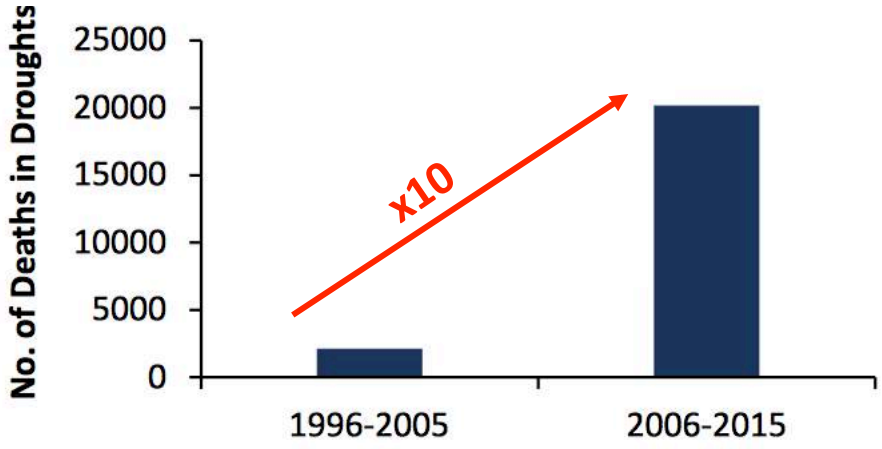
Center for Climate and Energy Solutions: https://www.c2es.org/content/heat-waves-and-climate-change/

Global extreme weather events on the rise

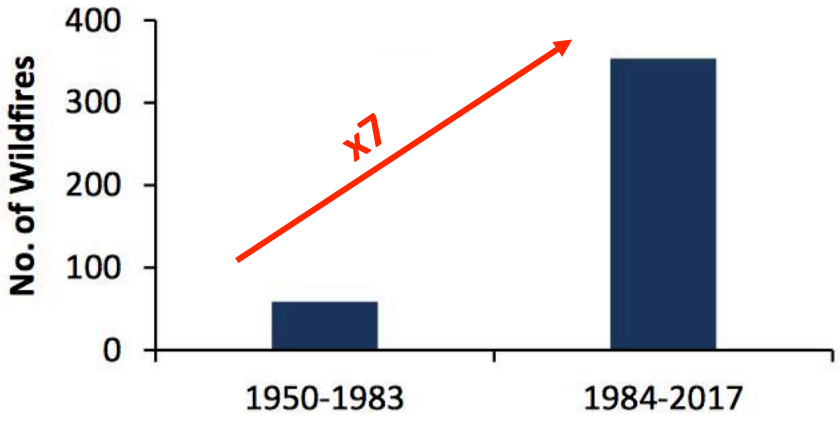
Floods



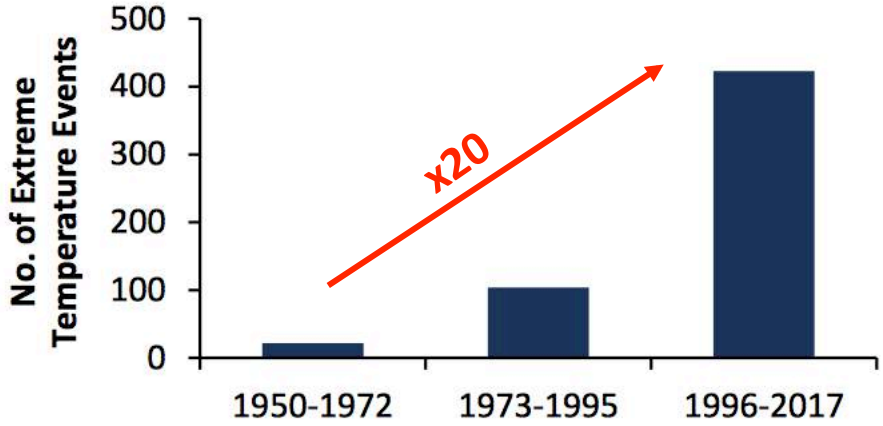
Drought Mortality



Wildfires



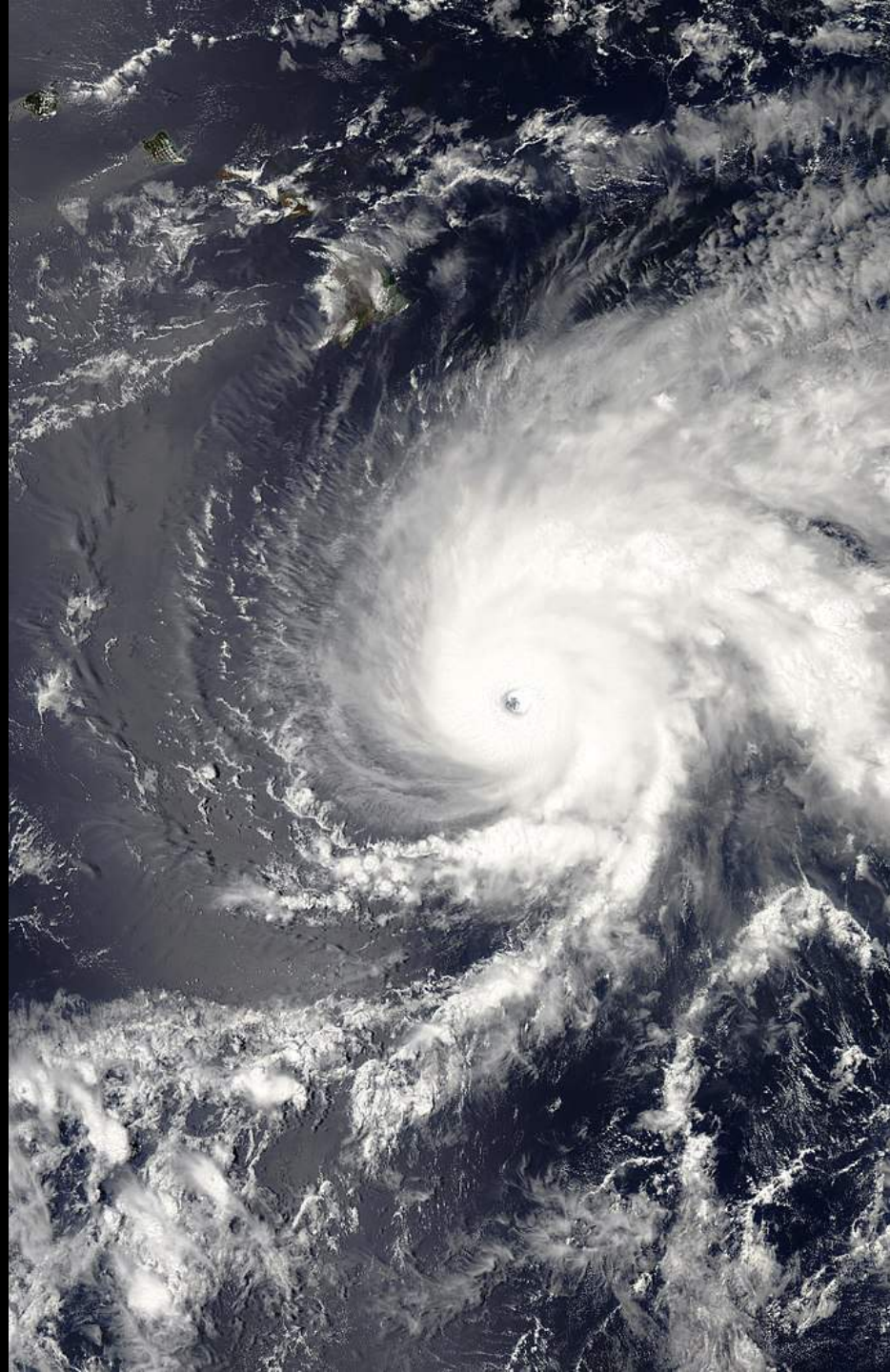
Extreme Temperature Events



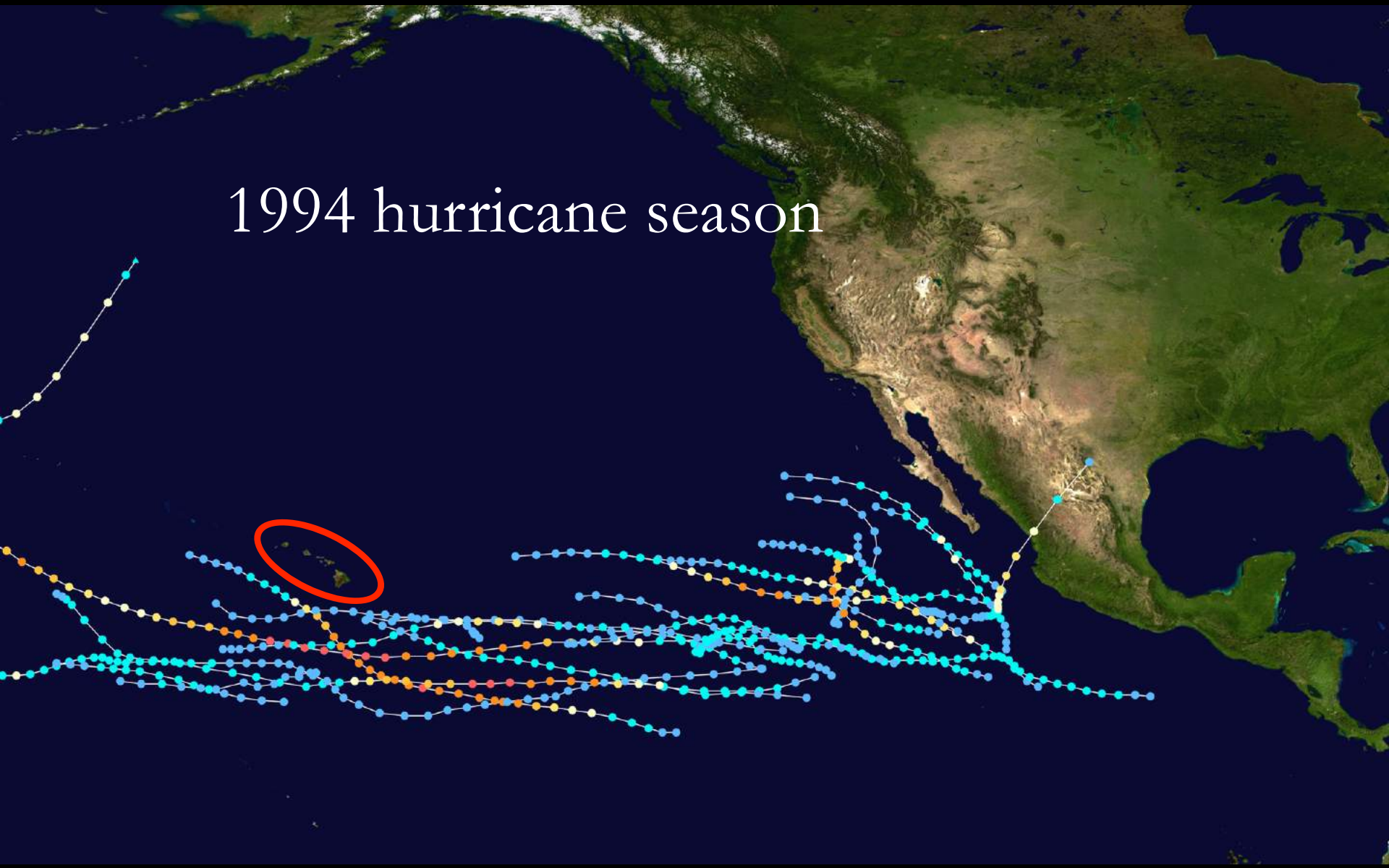
https://www.gmo.com/docs/default-source/research-and-commentary/strategies/asset-allocation/the-race-of-our-lives-revisited.pdf?sfvrsn=4. International Disasters database: https://www.emdat.be

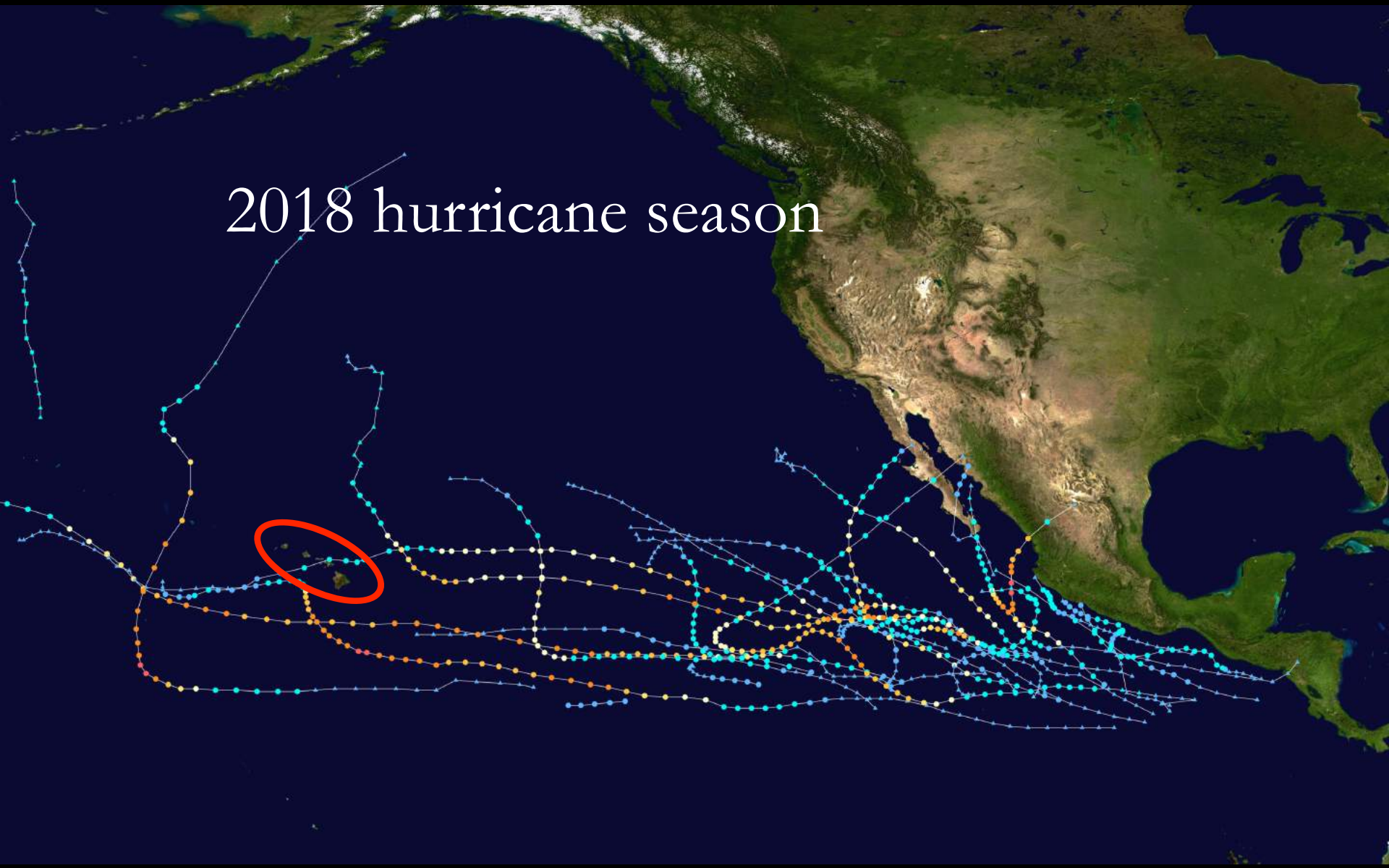
Hurricanes and Climate Change

- Warmer water = More fuel
- Larger
- More rain
- Stronger wind = Higher category
- Slower = More damage
- Higher storm surge
- Shifting away from equator

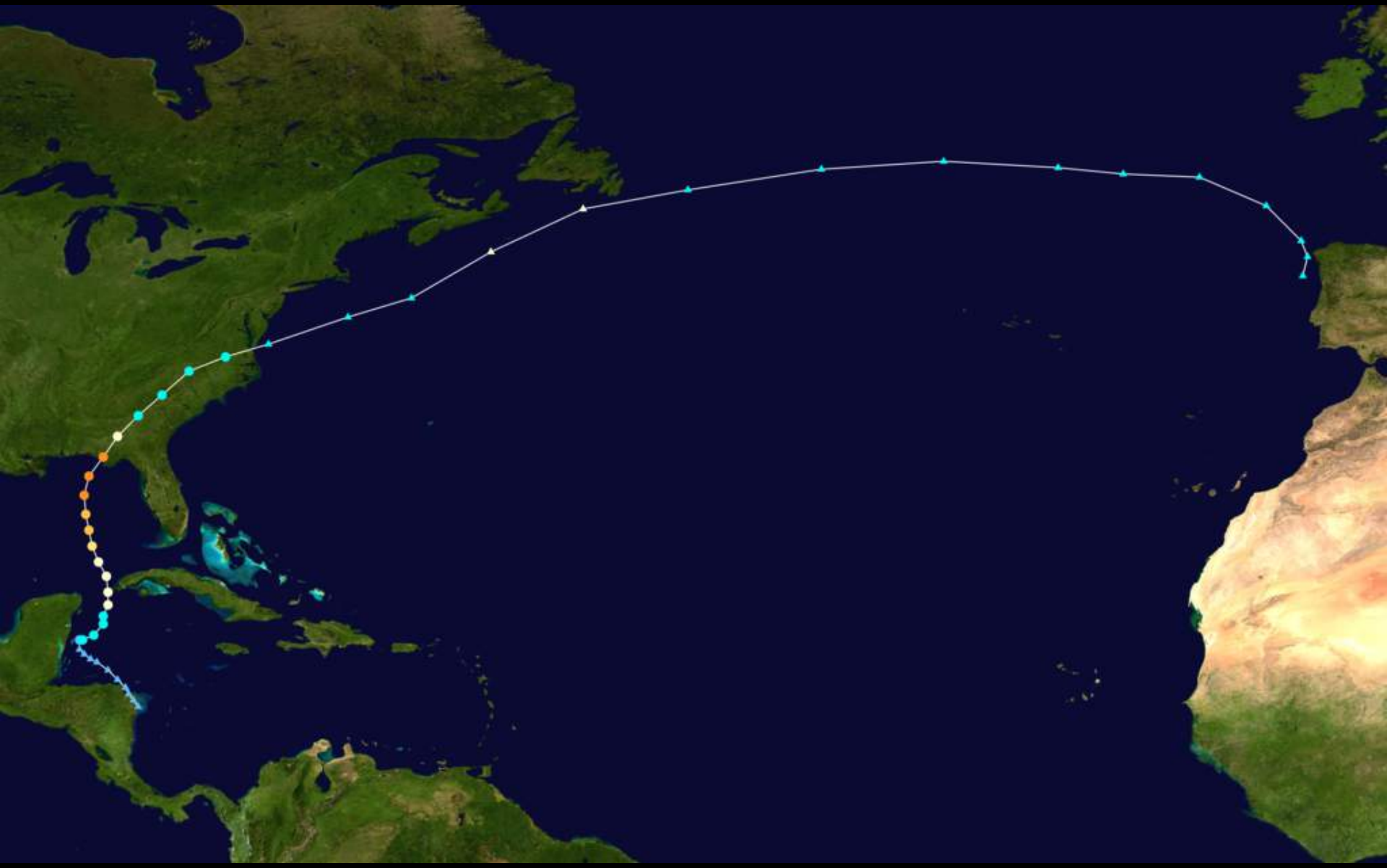


Does Global Warming Make Hurricanes Stronger? http://www.realclimate.org/index.php/archives/2018/05/does-global-warming-make-tropical-cyclones-stronger/


1994 hurricane season


2018 hurricane season

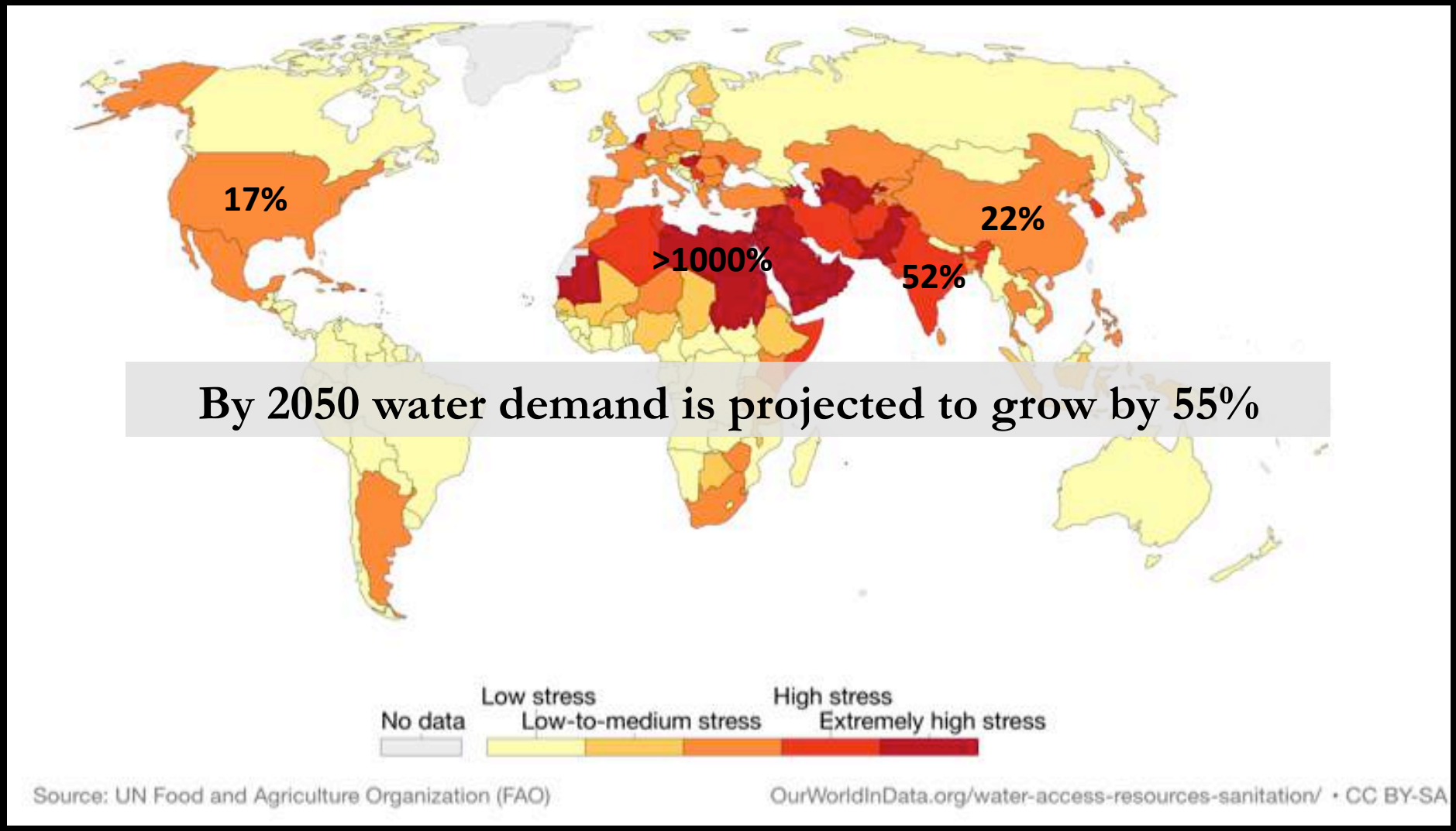
Hurricane Michael, Florida Panhandle, October, 2018



Hurricane Michael, Florida Panhandle, October, 2018

https://www.dni.gov/files/documents/Special%20Report_ICA%20Global%20Water%20Security.pdf

Freshwater withdrawals are already exceeding internal sources



https://ourworldindata.org/water-access-resources-sanitation#water-stress-and-scarcity

Food is less nutritious.

Decreased zinc, iron, and protein

nature
International journal of science

Letter

Increasing CO_2 threatens human nutrition

Samuel S. Myers, Antonella Zanobetti, Itai Kloog, Peter Huybers, Andrew D. B. Leakey, Arnold J. Bloom, Eli Carlisle, Lee H. Dietterich, Glenn Fitzgerald, Toshihiro Hasegawa, N. Michele Holbrook, Randall L. Nelson, Michael J. Ottman, Victor Raboy, Hidemitsu Sakai, Karla A. Sartor, Joel Schwartz, Saman Seneweera, Michael Tausz & Yasuhiro Usui

Nature **510**, 139–142 (05 June 2014)
doi:10.1038/nature13179
Download Citation
Environmental health

Received: 25 November 2013
Accepted: 24 February 2014
Published online: 07 May 2014

Abstract

Dietary deficiencies of zinc and iron are a substantial global public health problem. An estimated two billion people suffer these deficiencies[1], causing a loss of 63 million life-years annually[2,3]. Most of these people depend on C_3 grains and legumes as their primary dietary source of zinc and iron. Here we report that C_3 grains and legumes have lower concentrations of zinc and iron when grown under field conditions at the elevated atmospheric CO_2 concentration predicted for the middle of this century. C_3 crops other than legumes also have lower concentrations of protein, whereas C_4 crops seem to be less affected. Differences between cultivars of a single crop suggest

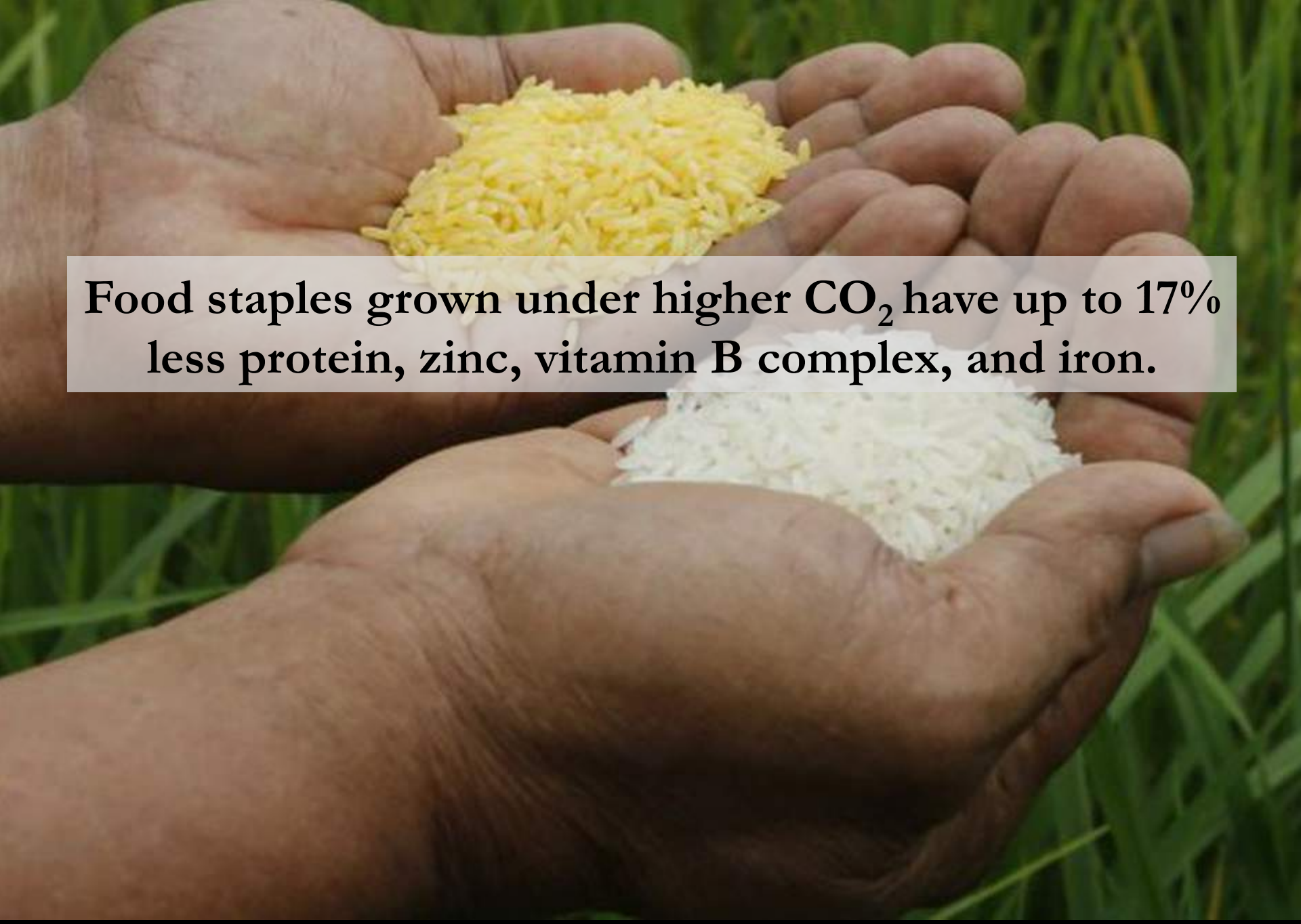
Editorial Summary

Crop nutrient loss in high CO_2

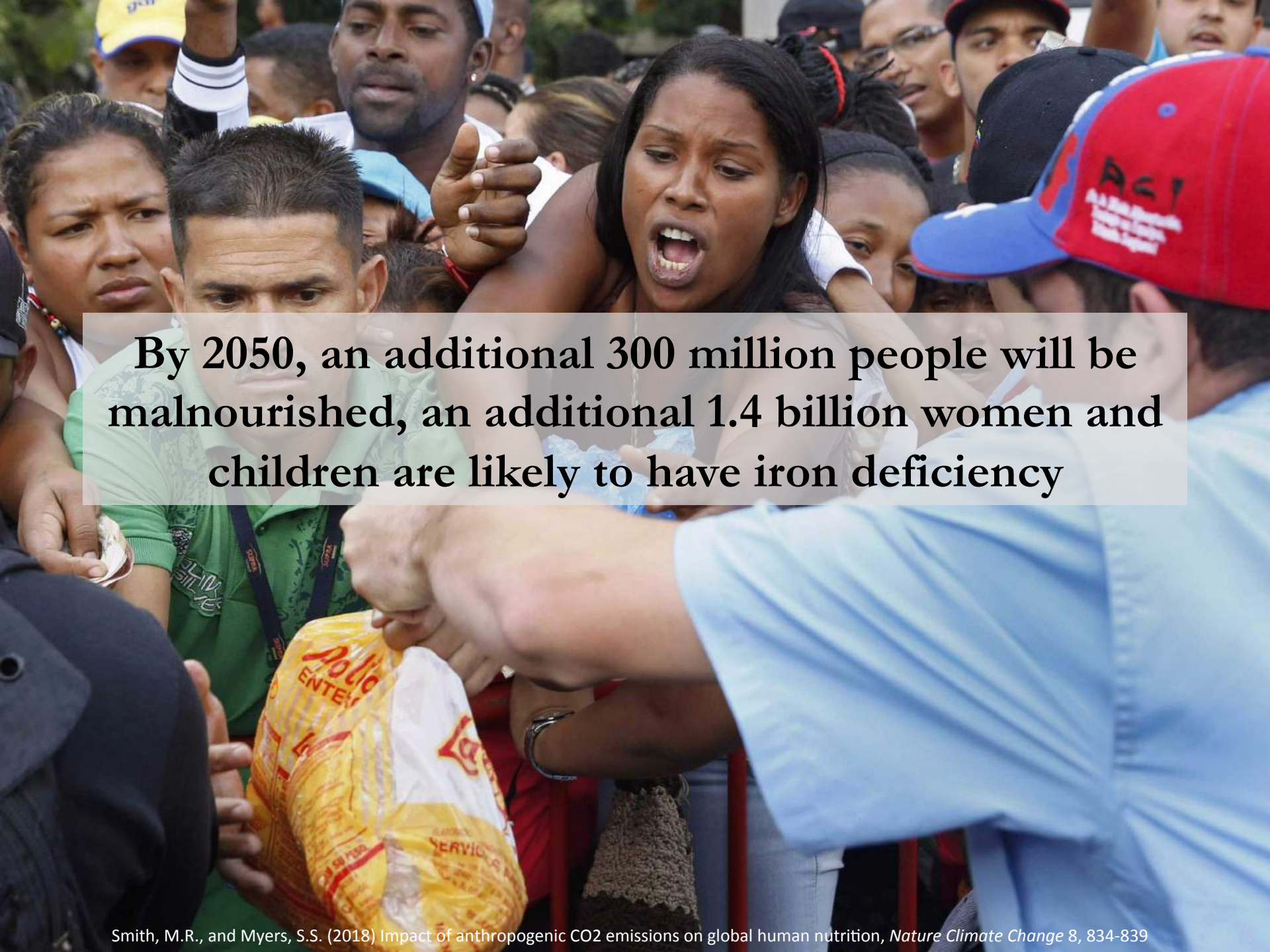
It has been suggested that the conce
of important nutrients such as zinc a
in food crops will decrease with incr
atmospheric CO_2 levels. However, so
studies have not found this, and som
those that have relied on non-field c
or did not focus on edible crop parts
Myers *et al.* have assembled the large
set to date from free-air CO_2 enrichr
experiments and find that C_3 crops (
and grasses) do indeed have reduced
iron levels under the elevated CO_2 c
predicted for the middle of this cent
Crops using the C_4 photosynthetic p
are less affected. These findings sugg
breeding cultivars for reduced sensit
elevated CO_2 may be an important p
health priority in many parts of the w
show less

Associated Content

Scientific Data | Data Descriptor | OPEN
Impacts of elevated atmosphe
on nutrient content of importa
crops
Lee H. Dietterich, Antonella Zanobetti [...]
Myers



Chunwu, Z et al (2018) Carbon dioxide levels (CO2) this century will alter the protein, micronutrients, and vitamin content of rice grains with potential health consequences for the poorest rice-dependent countries, *Science Advances*, May 23, v. 4, no. 5. Myers, S.S., et al. (2014) Increasing CO_2 threatens human nutrition, *Nature*, 510, 139-142, doi: 10.1038/nature13179.



By 2050, an additional 300 million people will be malnourished, an additional 1.4 billion women and children are likely to have iron deficiency

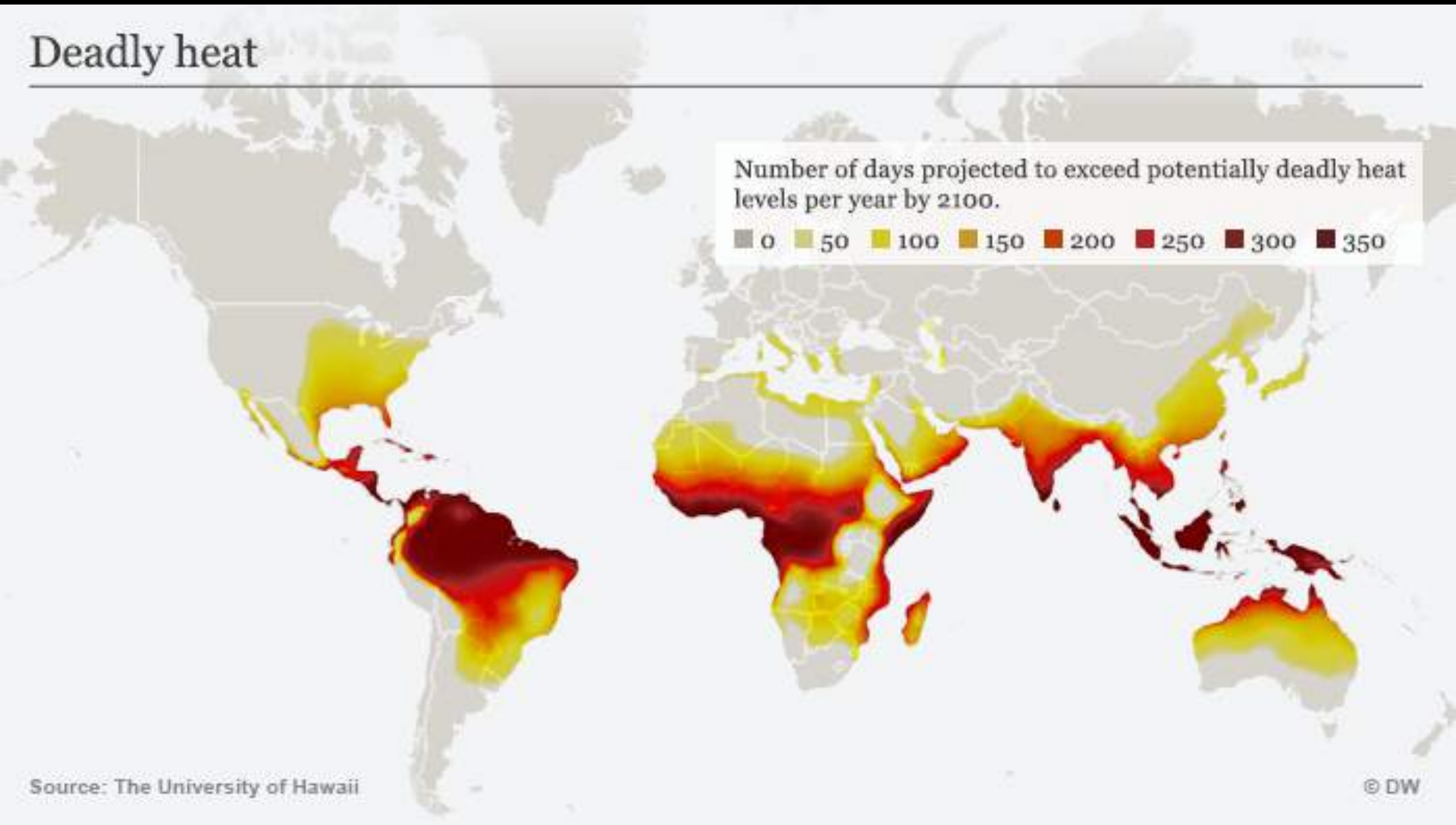
Smith, M.R., and Myers, S.S. (2018) Impact of anthropogenic CO2 emissions on global human nutrition, *Nature Climate Change* 8, 834-839

Food Shortages

- Global wheat provides 20% of human protein.
  - Yield is threatened by drought, flood, higher CO_2
  - By 2050 demand will increase by 60% (9 billion people)
  - But wheat yields will decline by 15%.

Deutsch, C.A., et al. (2018) Increase in crop losses to insect pests in a warming climate, *Science*, 31 August, v. 361, Iss. 6405, p. 916-919
Springmann, M. et al. Global and regional health effects of future food production under climate change: a modelling study. The Lancet, March 2, 2016 DOI: 10.1016/S0140-6736(15)01156-3. Myers et al, 2014 Increasing CO_2 threatens human nutrition, Nature 510, 139-142. Feng et al, 2015 Constraints to nitrogen acquisition of terrestrial plants under elevated CO_2, Global Change Biology, DOI: 10.1111/gcb.12938

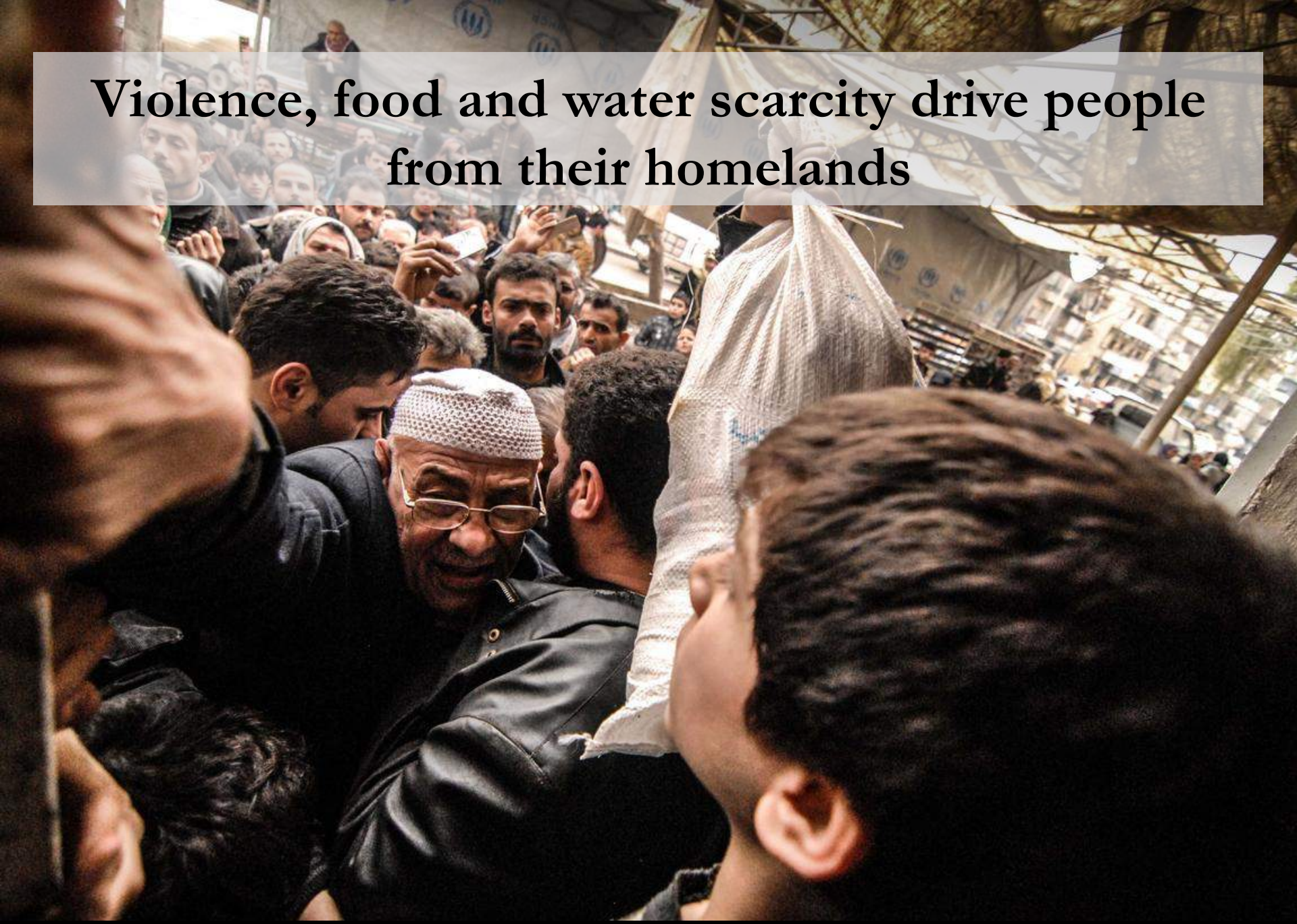
The Tropics are Becoming Unlivable



Mora C, et al. (2017) Global risk of deadly heat. *Nature Climate Change 7,* 501-506

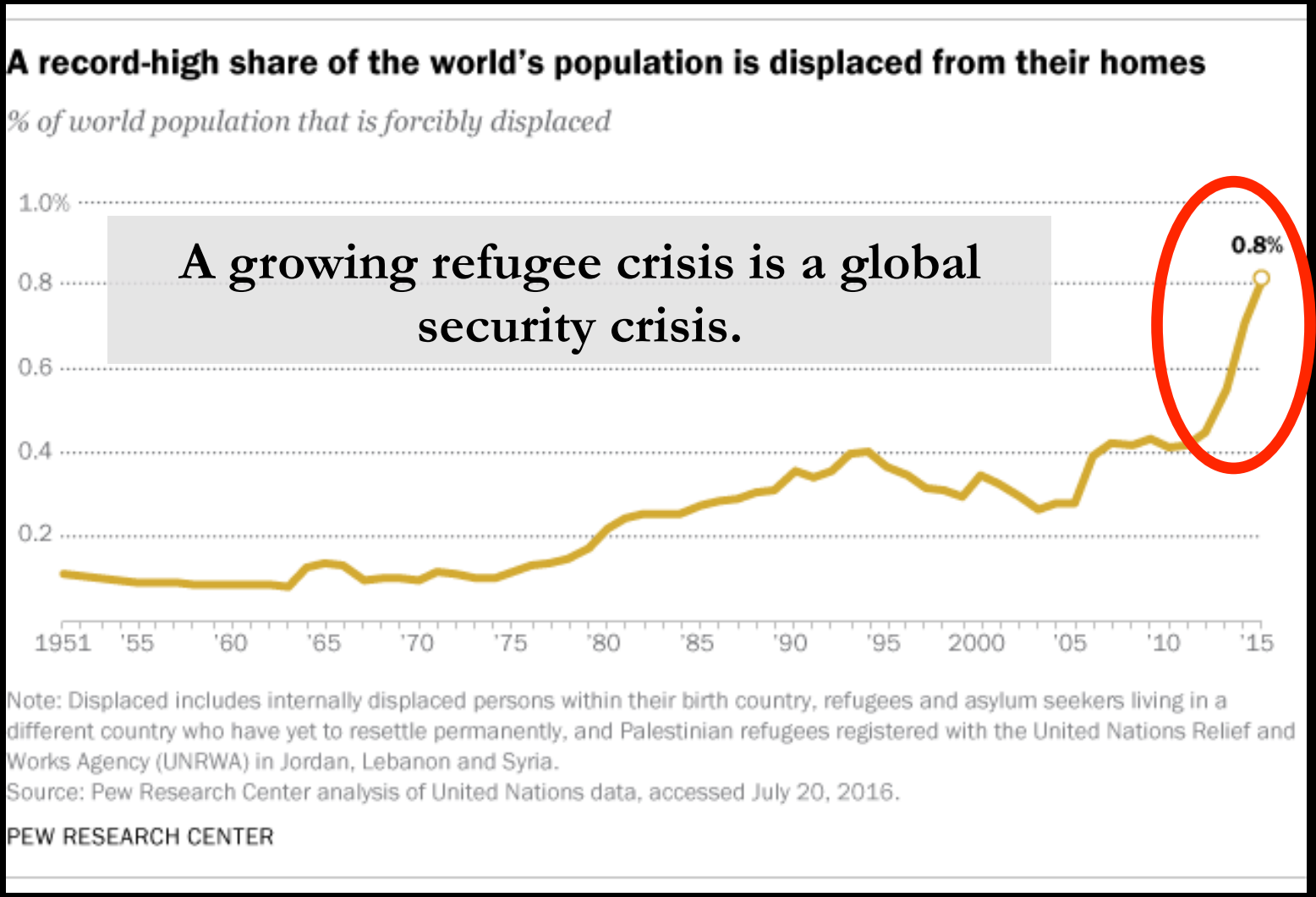
Food and water shortages can lead to violent conflict, refugee crises

Mora, C., et al. (2017) **Global risk of deadly heat.** *Nature Climate Change*; DOI: 10.1038/NCLIMATE3322



Violence, food and water scarcity drive people from their homelands

Worldwide nearly 1% of humanity are displaced from their homes



A growing refugee crisis is a global security crisis.

http://www.pewresearch.org/fact-tank/2016/08/03/nearly-1-in-100-worldwide-are-now-displaced-from-their-homes/

Drought in Syria led to civil war and terrorism

…the drought had a catalytic effect, contributing to political unrest.

…worst drought in 1000 yrs, causing widespread crop failure and a mass migration of farming families to urban centers.

NEW RESEARCH IN Physical Sciences

Climate change in the Fertile Cresc… implications of the recent Syrian dro…

Colin P. Kelley, Shahrzad Mohtadi, Mark A. Cane, Richard Seager, and Yocha…

PNAS 2015 March, 112 (11) 3241-3246. https://doi.org/10.1073/pnas.1421533112

Edited by Brian John Hoskins, Imperial College London, London, United Kingdom, and approved Ja… (received for review November 16, 2014)

Significance

There is evidence that the 2007–2010 drought contributed to …nflict in Syria. It was the worst drought in the instrumental record, causing wide… …ad crop failure and a mass migration of farming families to urban centers. Century-l… …g observed trends in precipitation, temperature, and sea-level pressure, supported by climate model results, strongly suggest that anthropogenic forcing has increased the probability of severe and …sistent droughts in this region, and made the occurrence of a 3-year drought as severe …at of 2007–2010 2 to 3 times more likely than by natural variability alone. We …ude that human influences on the climate system are implicated in the current Syrian …t.

…ract

… Syrian uprising that began in 2011, the greater Fertile Crescent experienced the …ught in the instrumental record. For Syria, a country marked by poor governa… …stainable agricultural and environmental policies, the drought had a catalytic effect, c… …to political unrest. We show that the recent decrease in Syrian precipitation is a combina… …natural variability and a long-term drying trend, and the unusual severity of the observed dr… …ht is here shown to be highly unlikely without this trend. Precipitation changes in Syria are linked to rising mean sea-level pressure in the Eastern Mediterranean, which also shows a long-term trend. There has been also a long-term warming trend in the Eastern Mediterranean, adding to the drawdown of soil moisture. No natural cause is apparent for these trends, whereas the observed drying and warming are consistent with model studies of the response to increases in greenhouse gases. Furthermore, model studies show an increasingly drier and hotter future mean

…s Classification

Physical Sciences

Ising model and ecology

F-donating electrolyte for 5-V Li metal battery

Abrupt change of superconducting gap in $FeSe_{1-x}S_x$

Show more

Earth, Atmospheric, and Planetary Sciences

Precipitation formation from cloud seeding

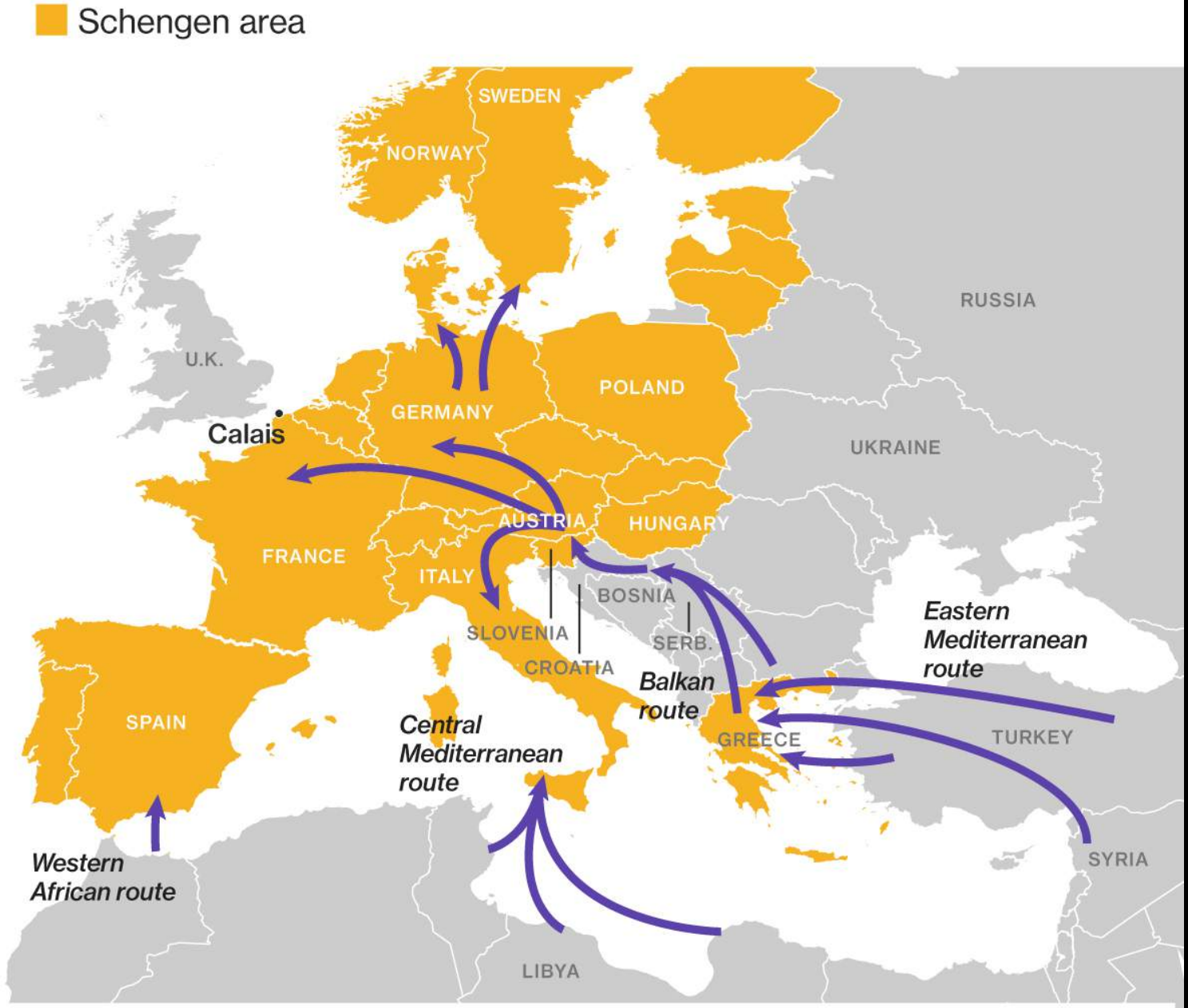
Eocene tropical SST from clumped isotopes

Related Content

Cited by...

Similar Articles

Migratory Routes



Sources: Frontex, i-map

Bloomberg Graphics

Syrian refugees flooded into Europe by the millions

… creating a backlash among residents

Sebastian Kurz.....campaigned on the need for tougher immigration controls, quickly deporting asylum-seekers whose requests are denied and outlawing the practice of Islam.

Bloomberg the Company & Its Products | Bloomberg Anywhere Remote Login | Bloomberg Terminal Demo Request

Bloomberg Businessweek

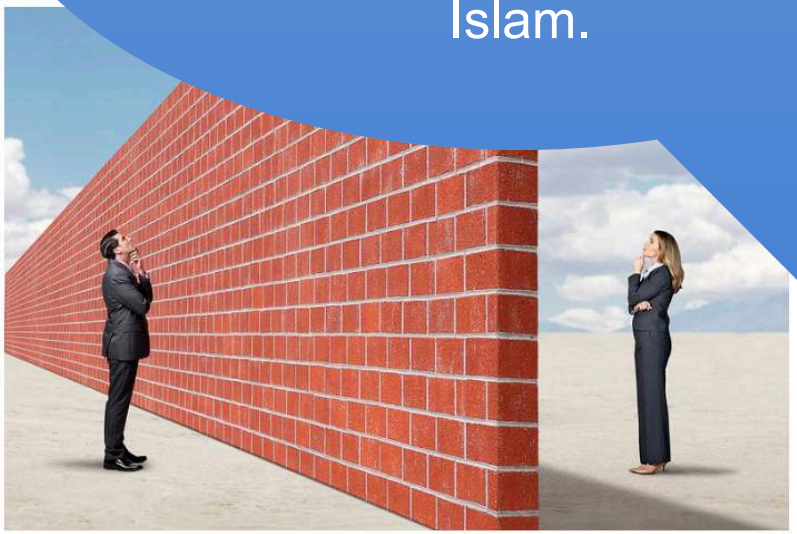
Markets Tech Pursuits Politics Opinion Businessweek

WATCH LIVE 8:42 AM Collins, Mur

October 19

N

By



▲ PHOTO ILLUSTRATION: 731; PHOTOS: BLOOMBERG (1), GETTY IMAGES (2)

As Europeans assess the fallout from the U.K.'s Brexit referendum, they face a series of elections that could equally shake the political establishment. In the coming 12 months, four of Europe's five largest economies have votes that will almost certainly mean serious gains for right-wing populists and nationalists. Once seen as fringe groups, France's National Front, Italy's Five Star Movement, and the Freedom Party in the Netherlands have attracted legions of followers by

CNBC HOME U.S. NEWS MARKETS INVESTING TECH MAKE IT VIDEO

EUROPE NEWS

UNITED KINGDOM | RUSSIA | GERMANY | FRANCE | EUROPEAN UNION

Austria likely takes a right turn as 31-year-old minister declares victory in election

- Ballot projections show Austrian foreign minister Sebastian Kurz's People's Party leading in a national vote.
- This puts Kurz on course to become Europe's youngest head of government.
- The party has focused on concerns about immigration and Islam.

Published 12:09 PM ET Sun, 15 Oct 2017 | Updated 22 Hours Ago

AP

Gallup | Getty Images

n Foreign Minister and leader of the conservative Austrian Peoples Party (OeVP) n Kurz speaks to media as he arrives to cast his ballot in Austrian parliamentary n October 15, 2017 in Vienna, Austria.

Austri year-old foreign minister declared victory for his party Sunday in tional election that set him up to become Europe's youngest lea and puts the country on course for a rightward turn.

Foreign Minister Se astian Kurz claimed the win as final results announced by the Interior Ministry showed his People's Party had a comfortable lead with almost all the ballots counted.
Noting that his center-right party had triumphed over the rival Social Democrats only twice since the end of World War II, Kurz called it a

THE NEW REPUBLIC

CLIMATE KINGS

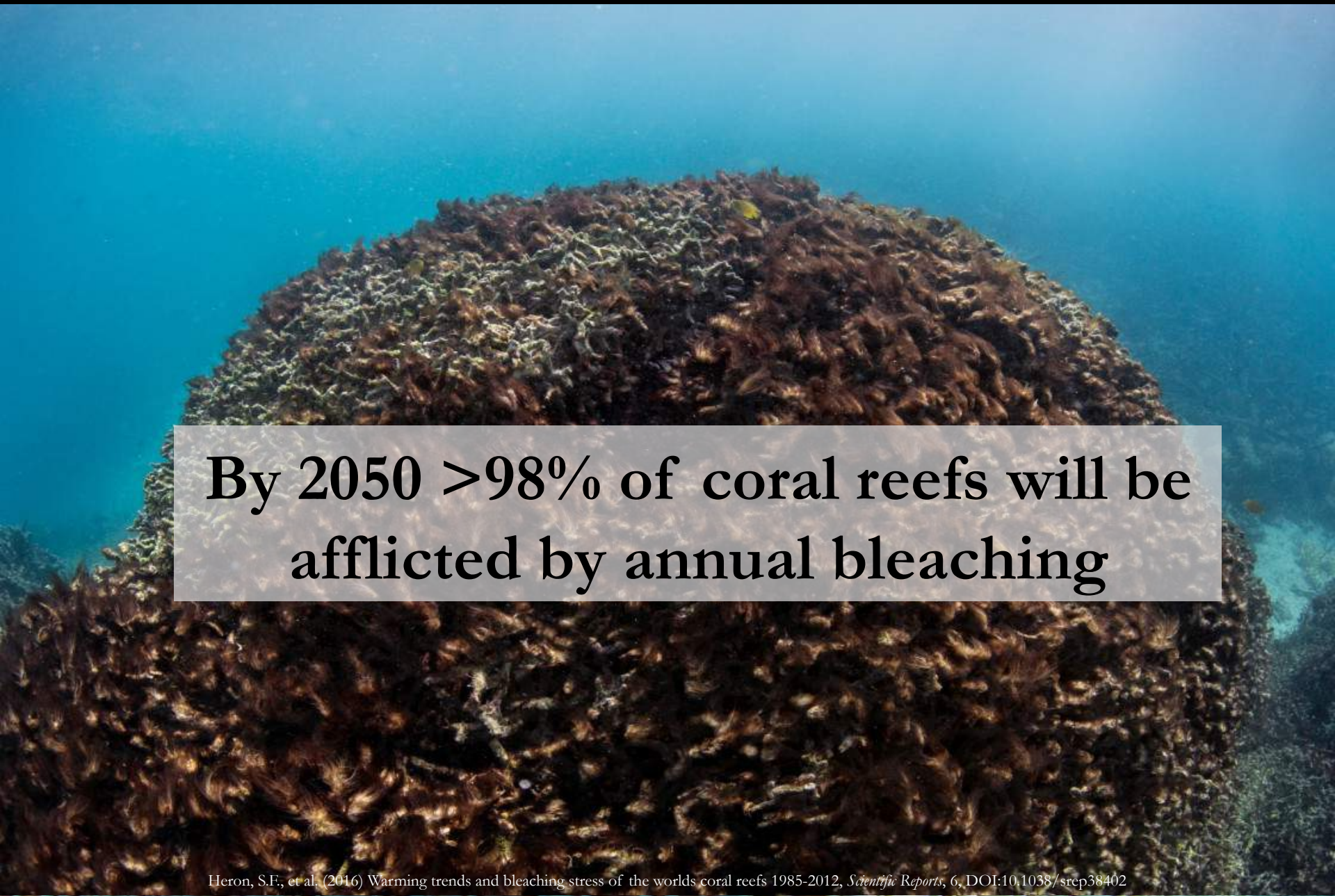
How a new generation of authoritarian leaders are using climate change to seize power.

By SAMUEL MILLER MCDONALD | July 30, 2018

Oceans are hotter, more acidic, with 2% less oxygen

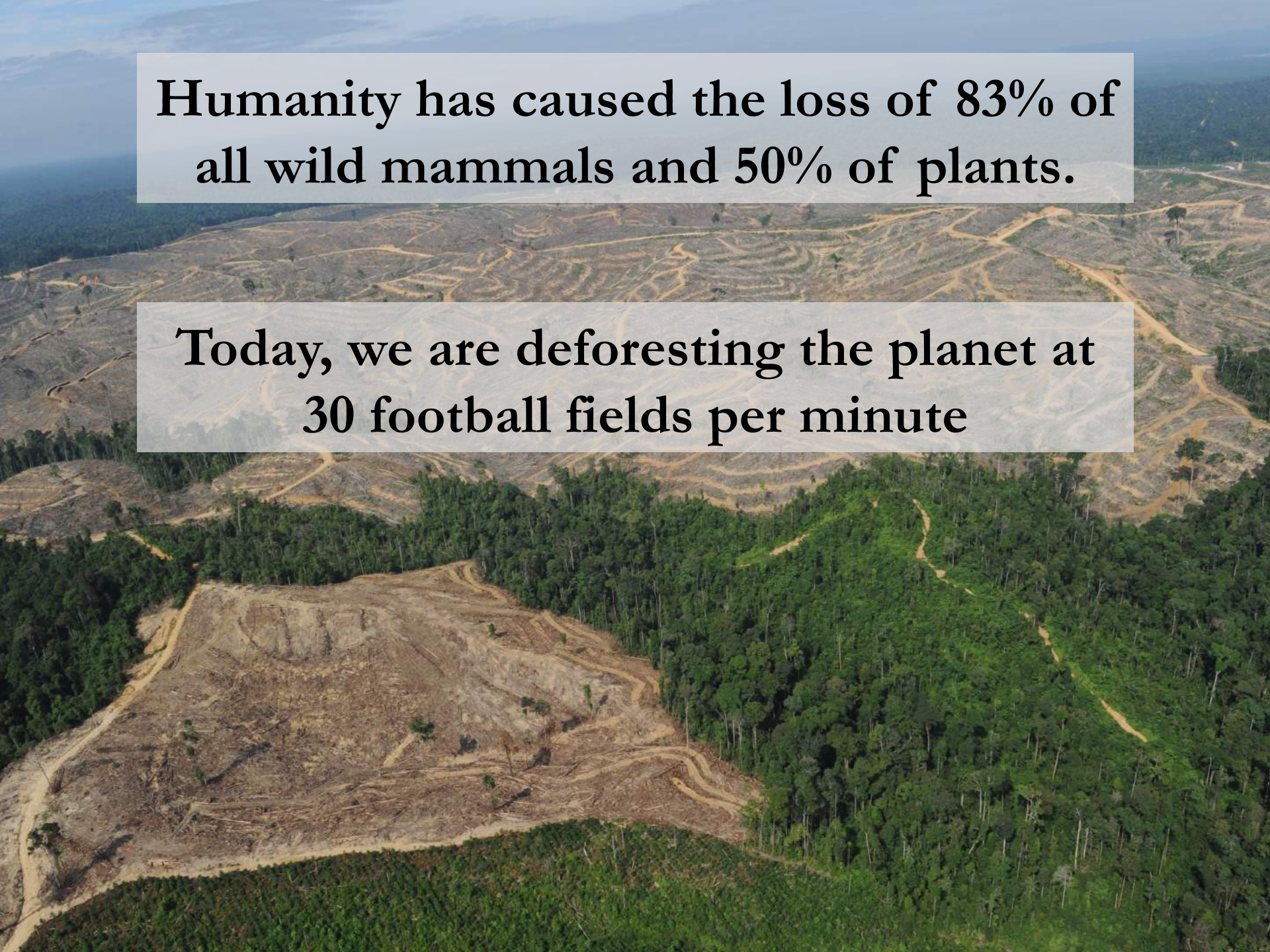
Cheng LJ and Zhu J (2018) 2017 was the warmest year on record for the global ocean. *Adv. Atmos. Sci.* Friedrich T et al (2012) Detecting Regional Anthropogenic Trends in Ocean Acidification against Natural Variability, *Nature Climate Change*. Takamitsu I et al (2017) Upper Ocean O trends: 1958-2015, *GRL*

Four global bleaching events since 1998, none prior



By 2050 >98% of coral reefs will be afflicted by annual bleaching

Heron, S.F., et al. (2016) Warming trends and bleaching stress of the worlds coral reefs 1985-2012, *Scientific Reports*, 6, DOI:10.1038/srep38402


Humanity has caused the loss of 83% of all wild mammals and 50% of plants.
Today, we are deforesting the planet at 30 football fields per minute

Bar-On, Y.O, Phillips, R., Milo, R. (2018) The biomass distribution on Earth, *PNAS*, 201711842; DOI:10.1073/pnas.1711842115

Over 15,000 scientists wrote "*Humans have pushed Earth's ecosystems to their breaking point and are well on the way to ruining the planet.*"

OXFORD ACADEMIC

BioScience

Issues | More Content ▾ | Submit ▾ | Purchase | Alerts | About ▾

Volume 67, Issue 12
December 2017

World Scientists' Warning to Humanity: A Second Notice

FREE

William J. Ripple, Christopher Wolf, Thomas M. Newsome, Mauro Galetti, Mohammed Alamgir, Eileen Crist, Mahmoud I. Mahmoud, William F. Laurance, 15,364 scientist signatories from 184 countries

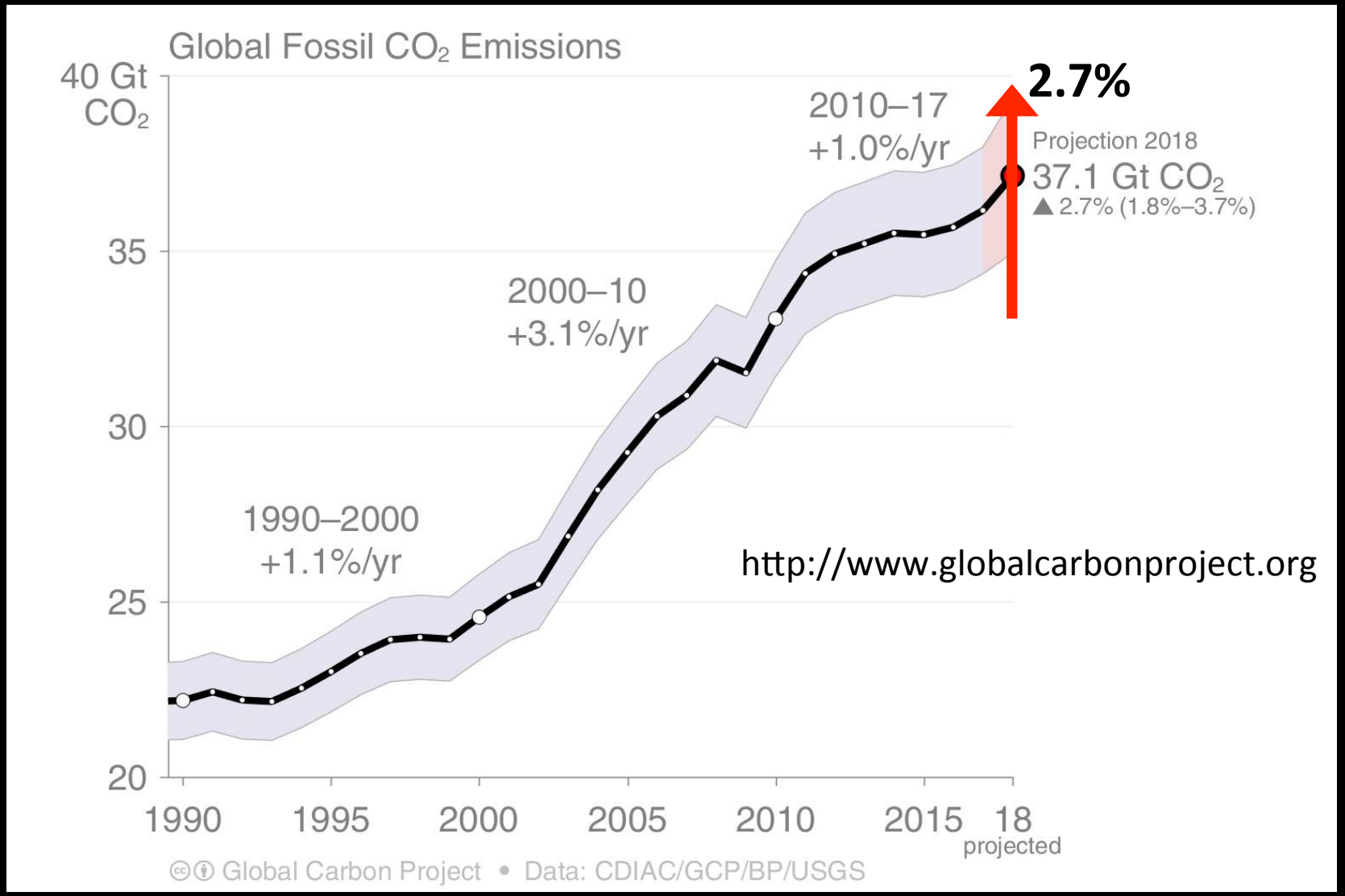
BioScience, Volume 67, Issue 12, 1 December 2017, Pages 1026–1028, https://doi.org/10.1093/biosci/bix125
Published: 13 November 2017

...an 1700 ...s in the sciences, penned the 1992 "World Scientists' Warning to Humanity" ... see supple- ... curtail ...stewardship of the Earth and the life on it is required, if vast human misery is to be av...oided." In their manifesto, they showed that humans were on a collision course ...with the natural world. They expressed concern about current, impending, or p...otential damage on planet Earth involving ozone depletion, freshwater availa...ility, marine life depletion, ocean dead zones, forest loss, biodiversity destruction, climate change, and continued human population growth. They proclaimed that fundamental changes were urgently needed to avoid the consequences our present course would bring.

The authors of the 1992 declaration feared that humanity was pushing Earth's ecosystems beyond their capacities to support the web of life. They described how we are fast approaching many of the limits of what the biosphere can tolerate without substantial and irreversible harm. The scientists pleaded that we stabilize the human population, describing how our large numbers—swelled by another 2 billion people since 1992, a 35 percent increase—exert stresses on Earth that can overwhelm other efforts to realize a sustainable future (Crist et al. 2017). They implored that we cut greenhouse gas (GHG) emissions and phase out fossil fuels, reduce deforestation,

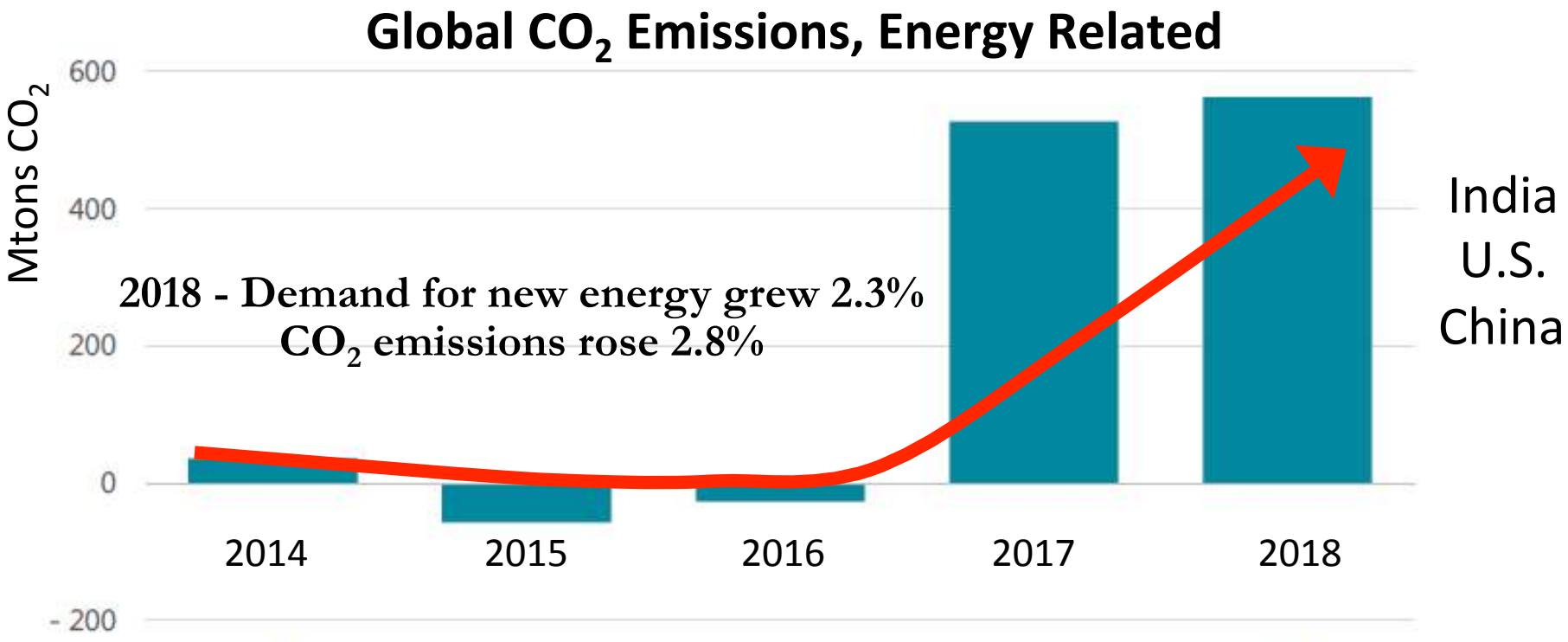
All of this is bad news…. But we‘re doing something about it, right?

Carbon Dioxide Emissions Have Risen 3 yrs in a Row



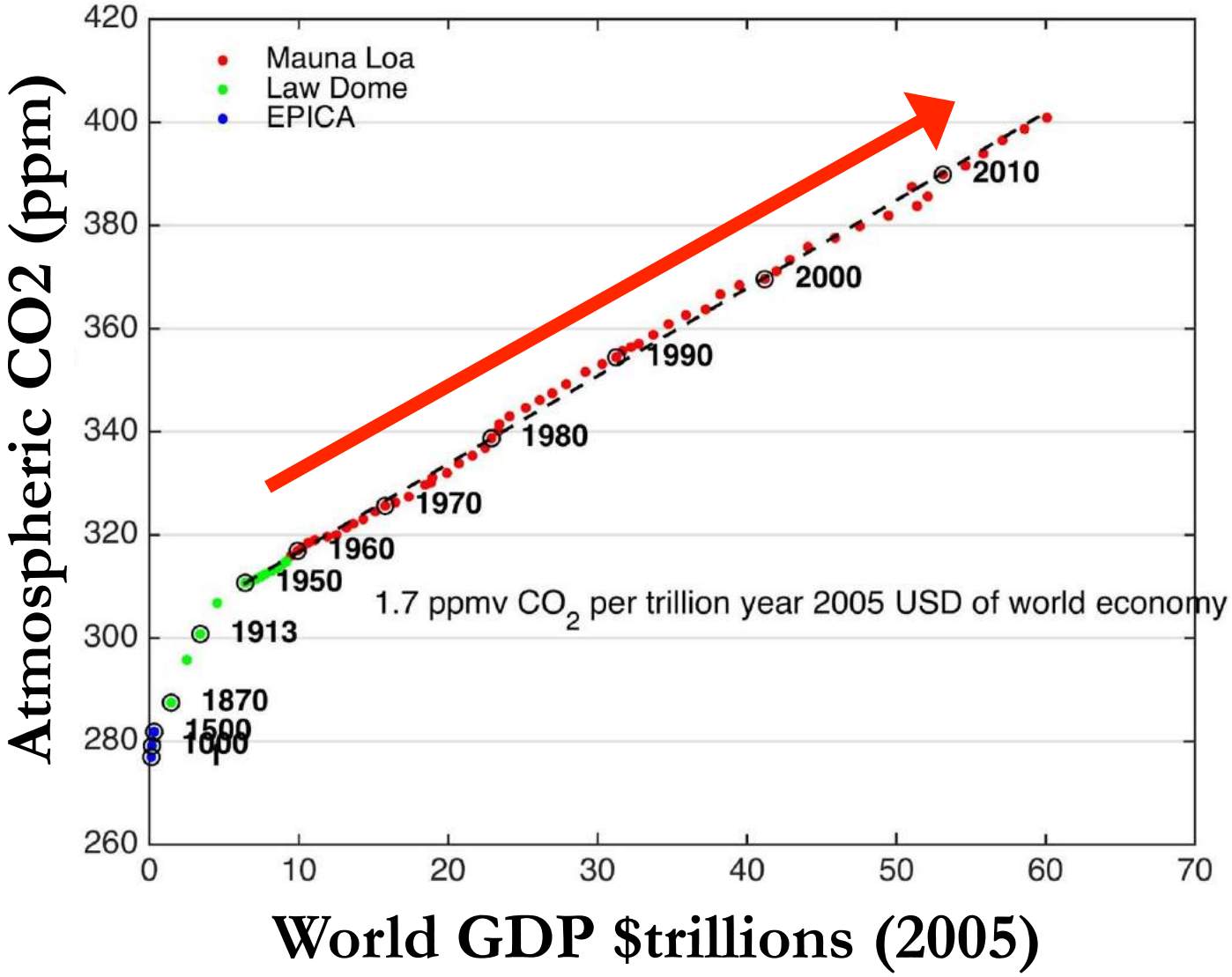
CO_2 Emissions rose because climate policy could not overcome economic growth.

The biggest factors pushing emissions down were energy efficiency & renewables, but they would have to be about **three times larger to overcome economic growth**.



https://twitter.com/Peters_Glen/status/1110454130441707523. IEA (2019) Global Energy and CO2 Statu Report, https://www.iea.org/geco/

Emissions Follow World GDP, +130% by 2050



Price Waterhouse Consultants (PwC) https://www.pwc.com/gx/en/issues/economy/the-world-in-2050.html

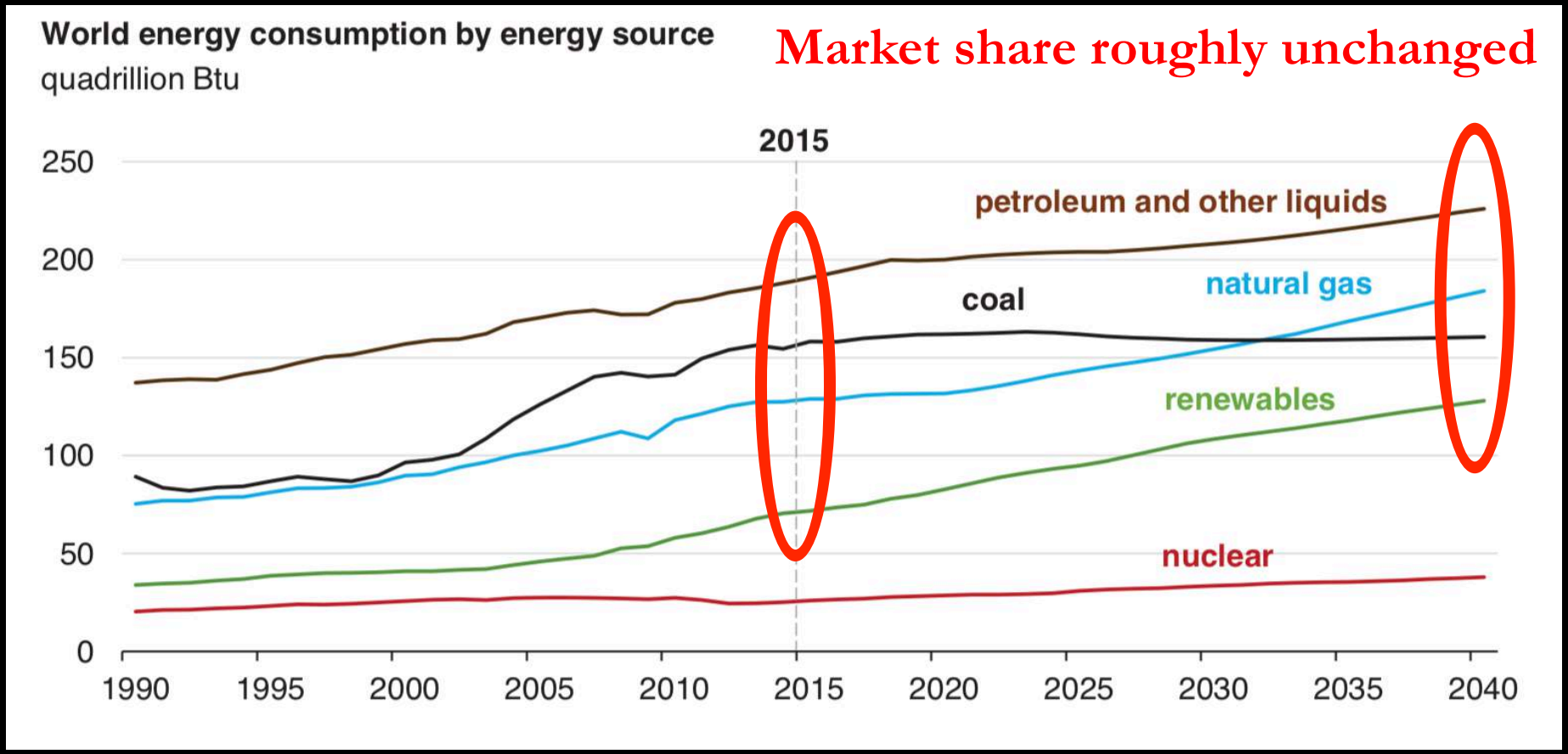
Tim Garrett - https://twitter.com/nephologue/status/1051218794679390209 Garrett, T. J.: No way out? The double-bind in seeking global prosperity alongside mitigated climate change, Earth Syst. Dynam., 3, 1-17, https://doi.org/10.5194/esd-3-1-2012, 2012.

- Energy demand set to grow >25% by 2040
- Renewables make up only two-thirds of new capacity
- Oil consumption grows due to rising demand for petrochemicals, trucking, aviation, energy
- CO_2 emissions continue to increase to mid-century

https://www.iea.org/weo/

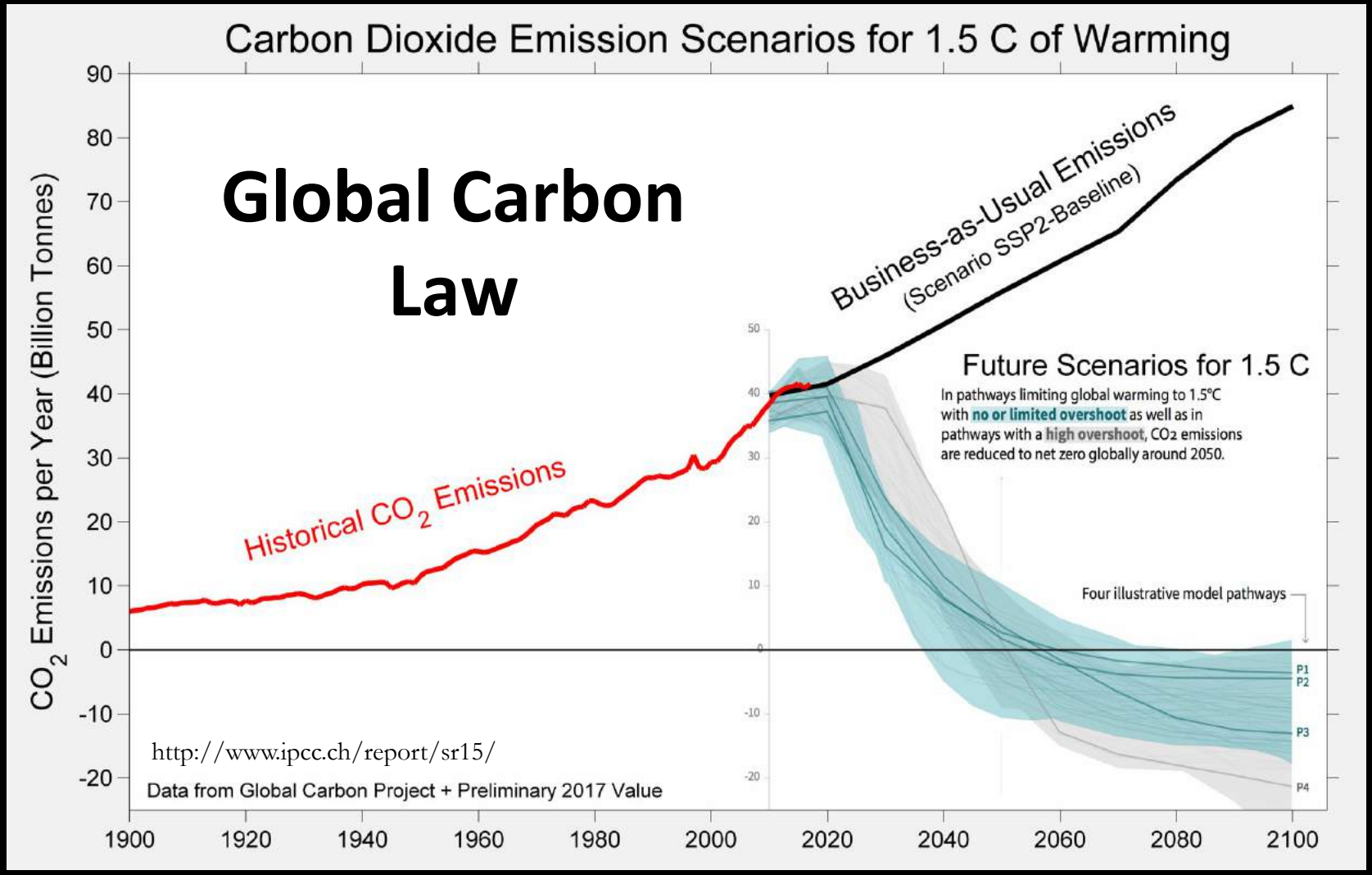
U.S. Energy Information Administration

Energy Consumption increases to 2040 for all fuels but coal

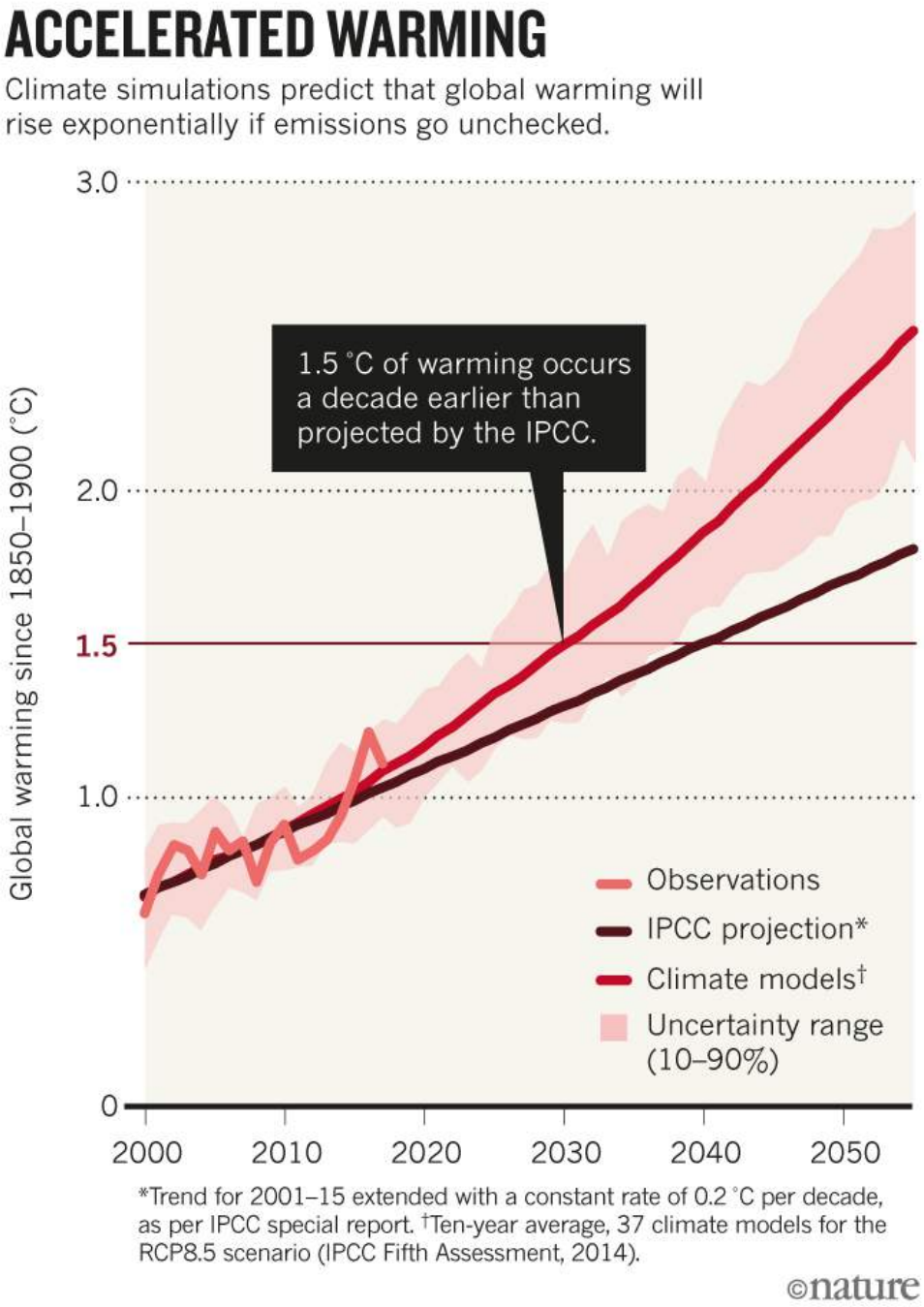


https://www.eia.gov/outlooks/ieo/exec_summ.php

Global emissions must cut 50% by 2030

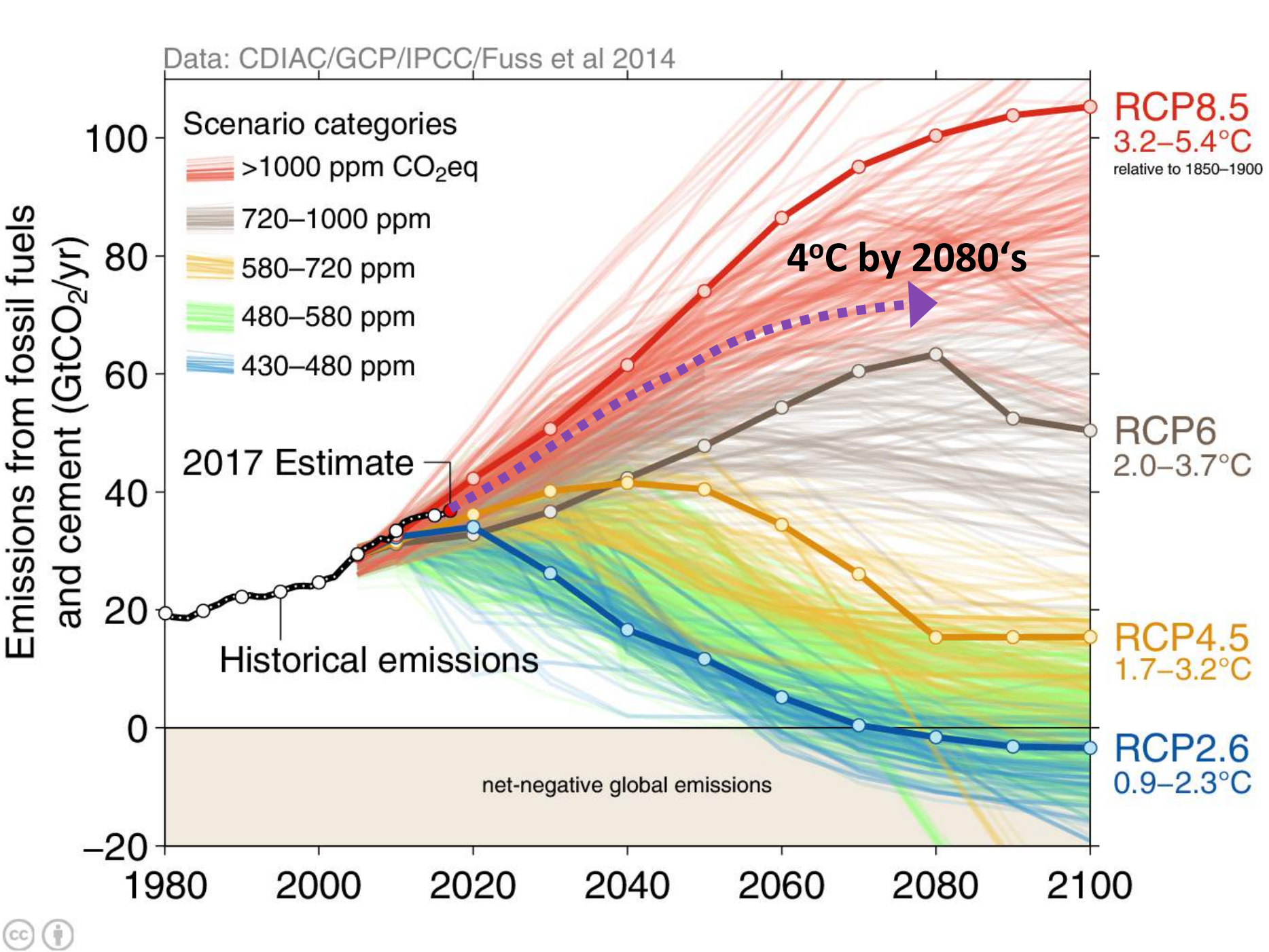


Rockström, J. et al. (2017) A roadmap for rapid decarbonization. *Science*, 355 (6331): 1269. Gasser, T., et al. (2015) Negative emissions physically needed to keep global warming below 2oC, *Nature Communications* 6, DOI: 10.1038/ncomms8958.



- Global Warming is Accelerating
  - Emissions rising
  - Emissions cleaner
  - Decreased ocean circulation
  - Pacific releasing heat (IPO)
- 1.5°C by 2030
- 2.0°C by 2045

ı, Y. et al. (2018) Global warming will happen faster than we think, *Nature*, v. 564, Dec. 6



Thank You For Your Time