



**Welcome
this evening**




Community Choir




Art



Nature



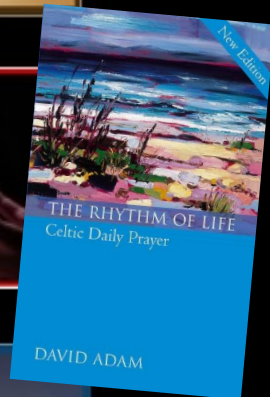

Eden Breakfast




Storytelling




Pray


Crafty Gaggle




Craft Group



EWG Good Book Club



IMMERSE
The Bible-Raising Experience™



Posada

Journey to Bethlehem





Nature

Curiosity
Appreciation
Celebration
Action
Opportunity

CACAO

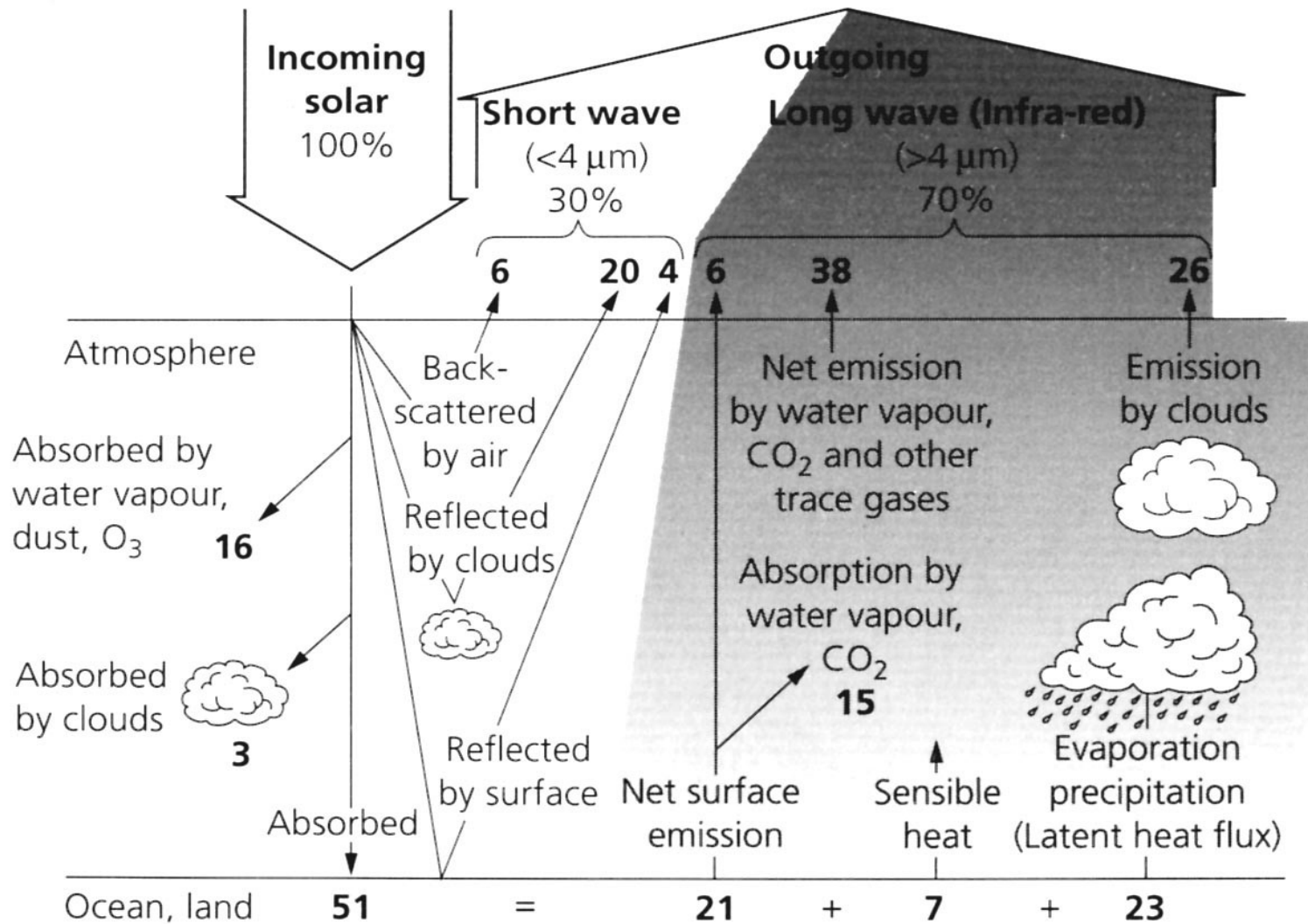
The Climate is Changing: but what on Earth can I do about it?

Dr Richard Waller
Senior Lecturer in Physical Geography
School of Physical & Geographical Sciences
Keele University

Talk Outline

- 1. Climate Change: the core science**
- 2. The Environmental Impacts**
- 3. Carbon Budgets and COP 26**
- 4. What can we do as individuals and communities?**
- 5. Envisioning a positive future**

1. Climate Change: the core science

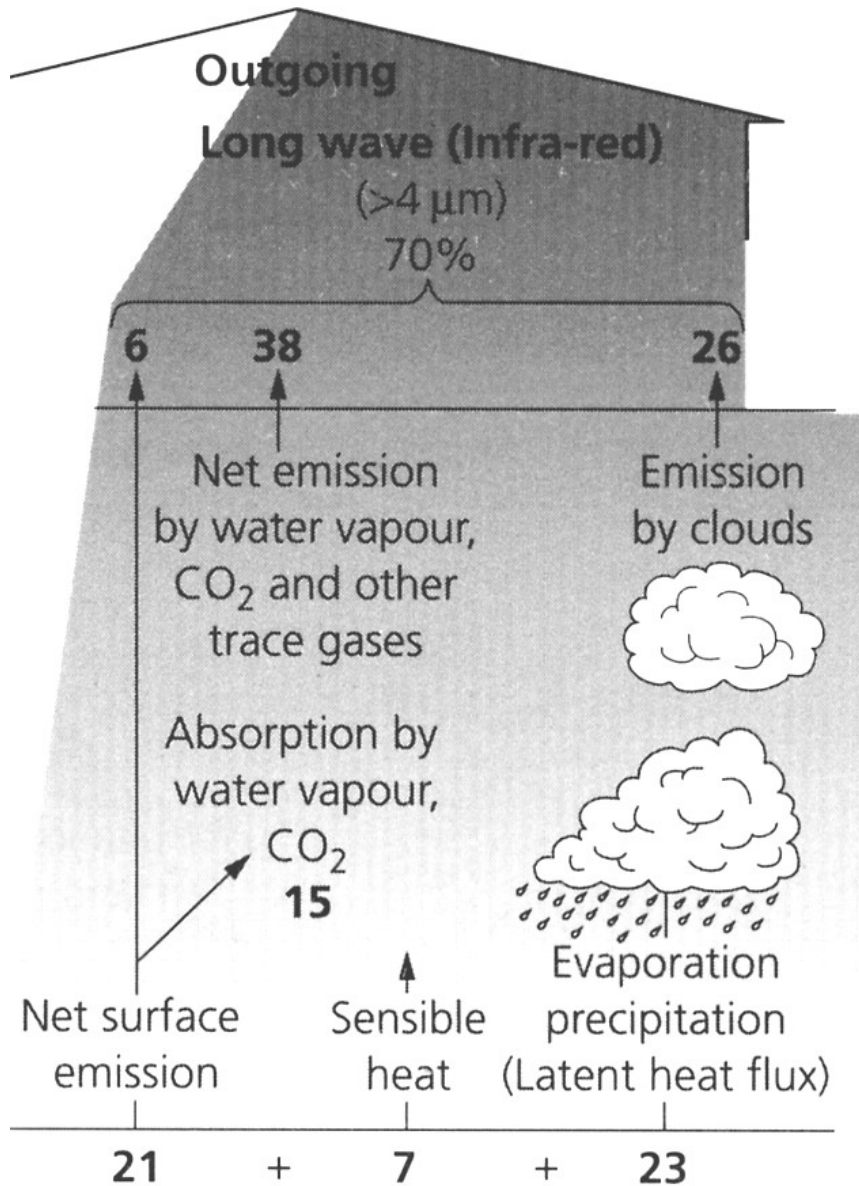


(Allen, 1997)

Terrestrial Radiation

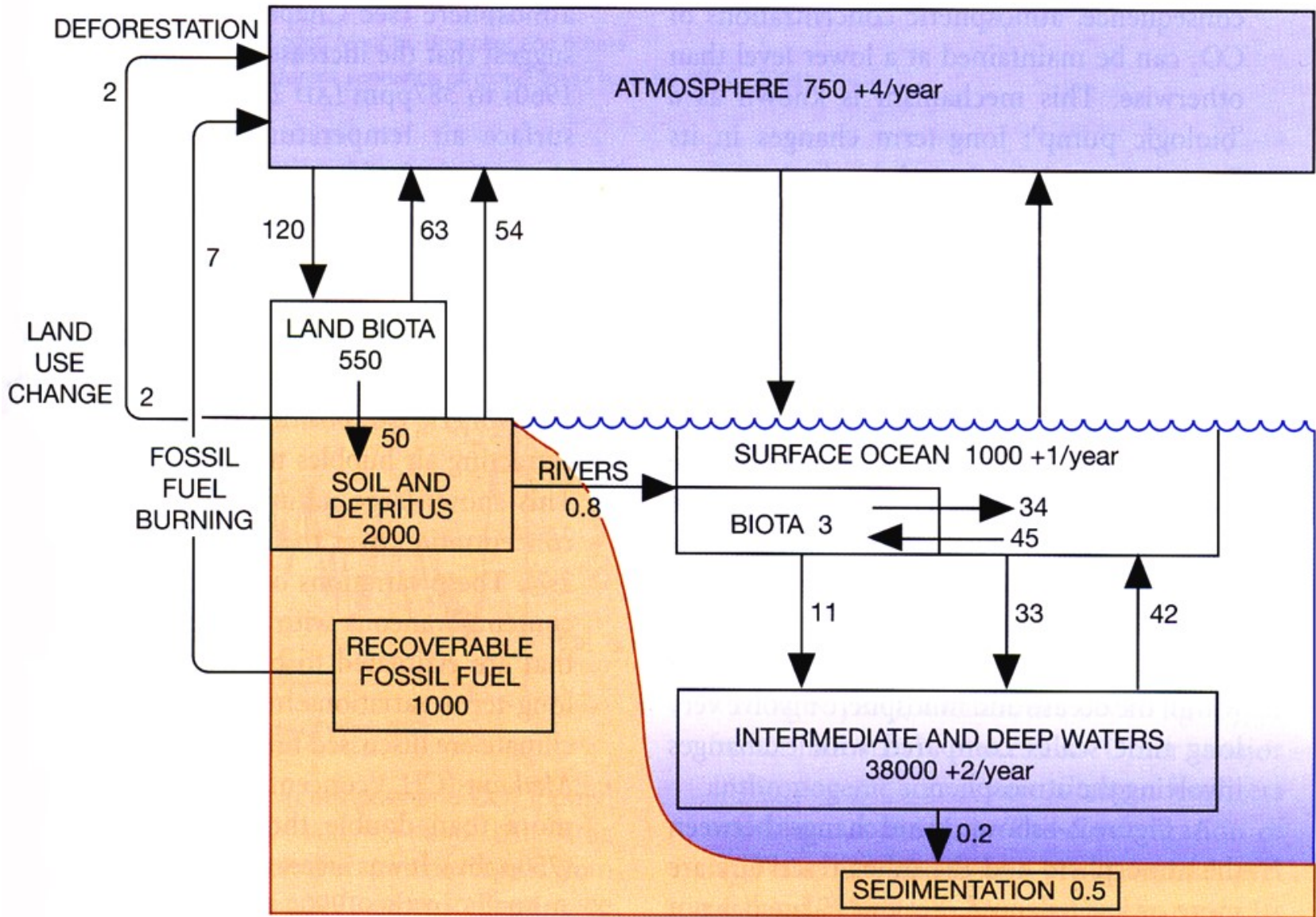
"Greenhouse effect" relates to the absorption of outgoing long-wave radiation from the Earth.

71% of outgoing long-wave radiation is absorbed contributing to atmospheric warming.

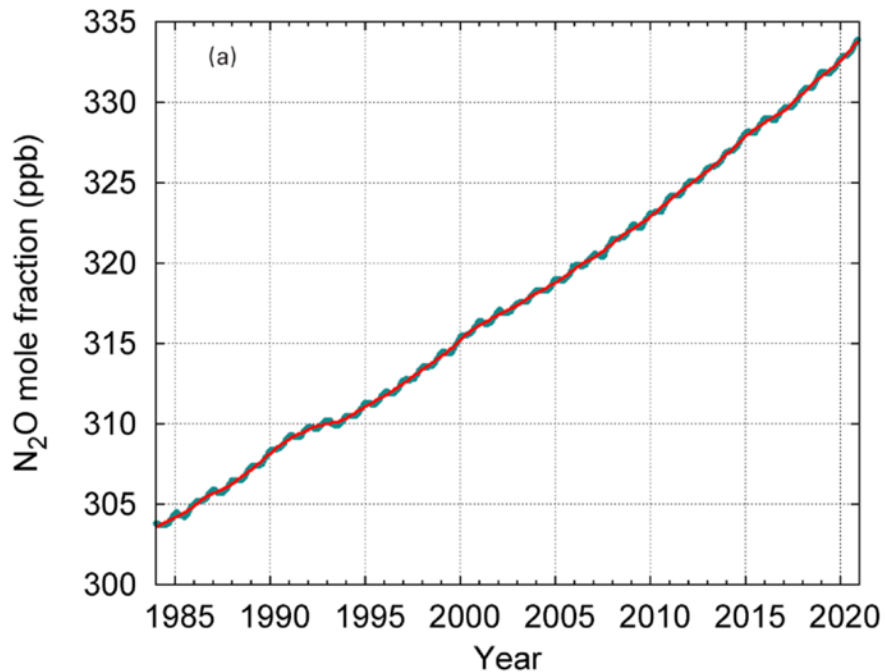
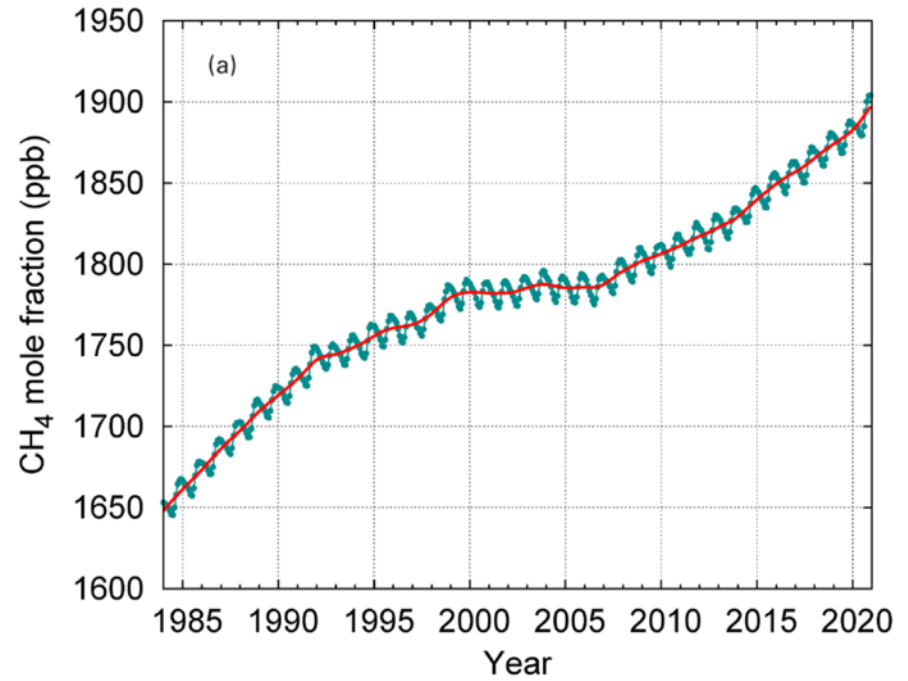
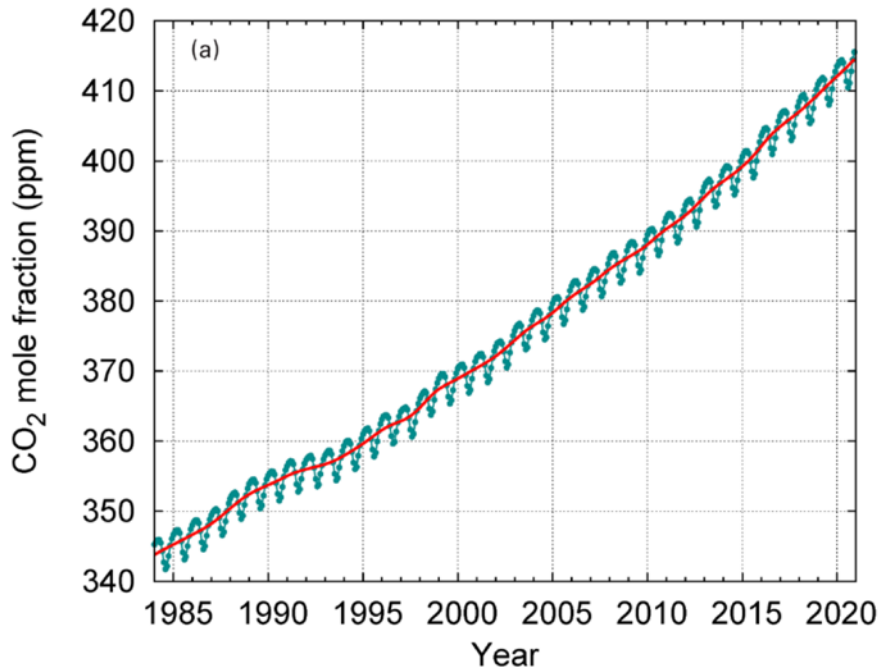


Net warming contribution of 33°C

- 21°C due to water vapour.
- 7°C due to carbon dioxide.
- 2°C due to ozone.
- 3°C due to other trace gases.



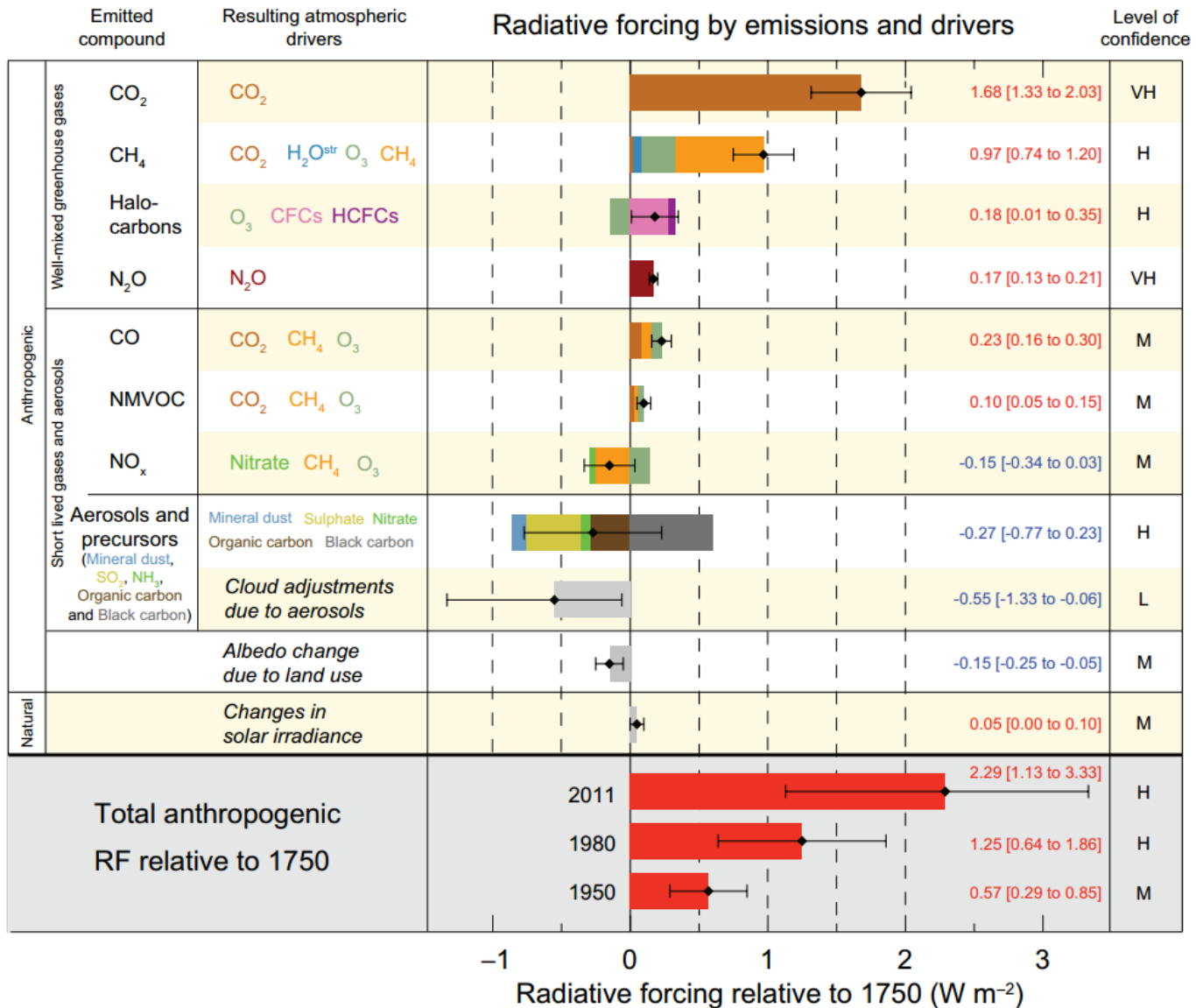
Global carbon reservoirs (GtC) and gross annual fluxes (GtC.yr⁻¹)
 (Barry & Chorley, 2010, p23)



Recent changes in the atmospheric concentration of the principal greenhouse gases:

- Carbon dioxide
- Methane
- Nitrous oxide

WMO Greenhouse Gas Bulletin (25 Oct 2021)
https://library.wmo.int/doc_num.php?explnum_id=10838



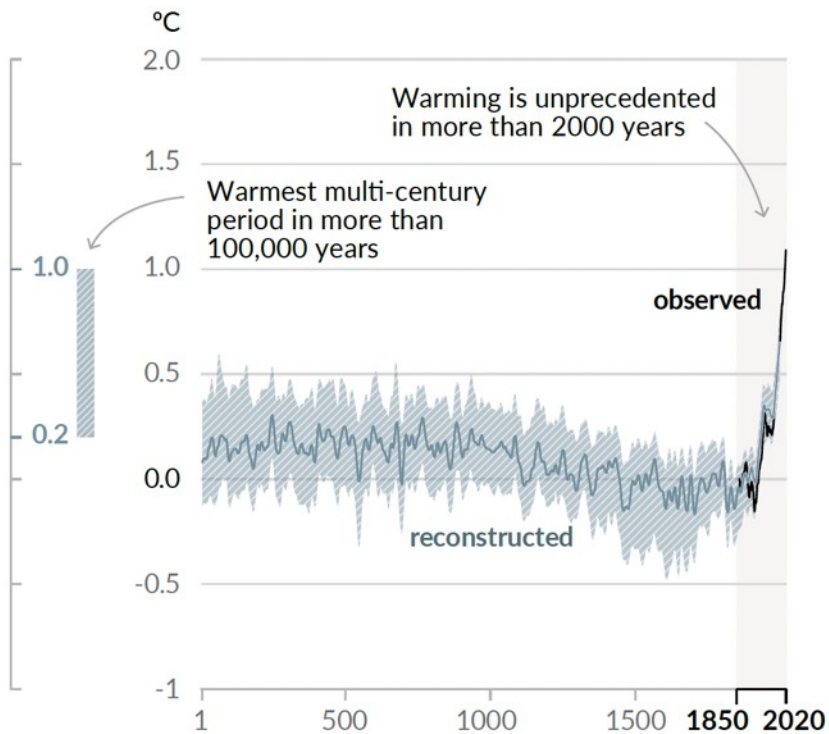
Radiative forcing estimates in 2011 relative to 1750.

(IPCC 2013 WG1 Summary Report)

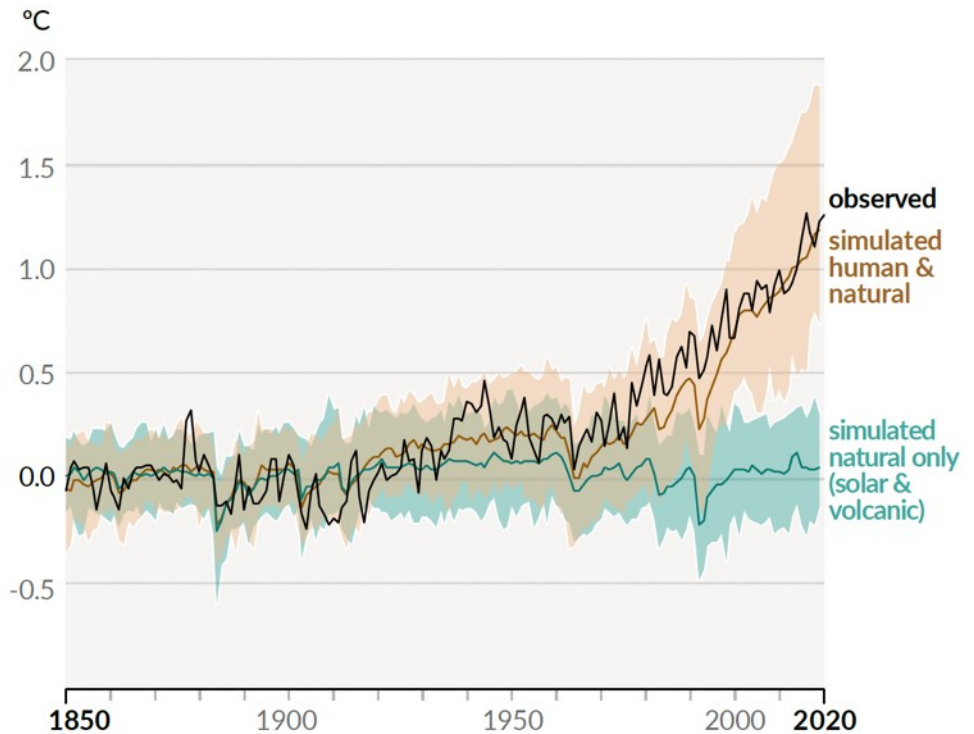
Human influence has warmed the climate at a rate that is unprecedented in at least the last 2000 years

Changes in global surface temperature relative to 1850-1900

a) Change in global surface temperature (decadal average) as **reconstructed** (1-2000) and **observed** (1850-2020)



b) Change in global surface temperature (annual average) as **observed** and simulated using **human & natural** and **only natural** factors (both 1850-2020)



2. The Environmental Impacts



Massive ice within the Mackenzie Delta region, western Canadian Arctic

Climate change is already affecting every inhabited region across the globe with human influence contributing to many observed changes in weather and climate extremes

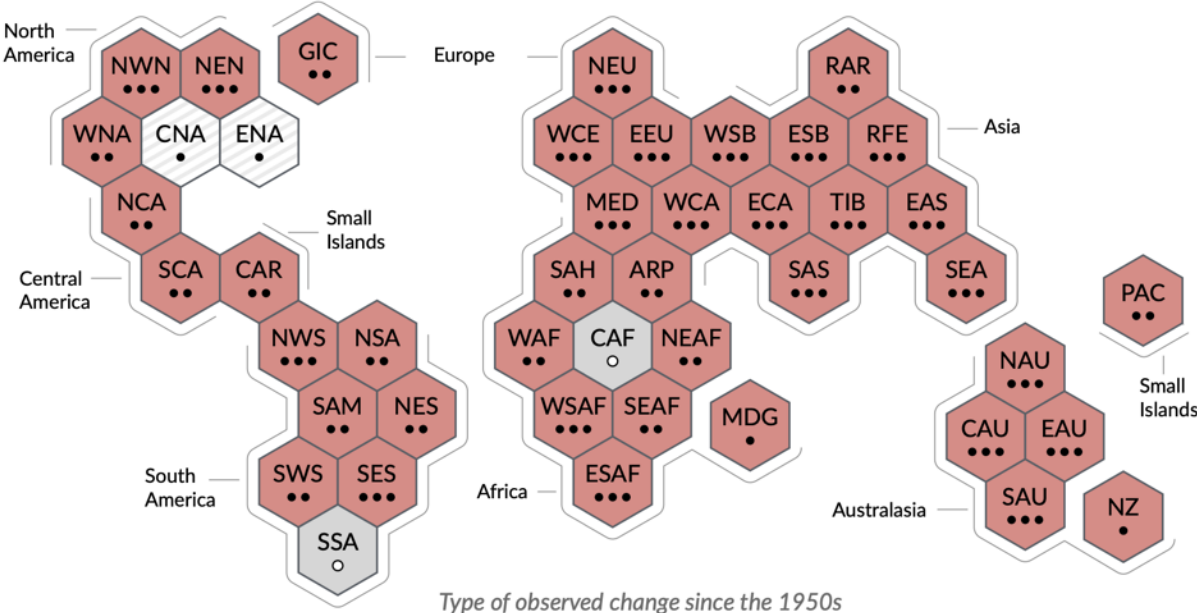
a) Synthesis of assessment of observed change in hot extremes and confidence in human contribution to the observed changes in the world's regions

Type of observed change in hot extremes

- Increase (41)
- Decrease (0)
- Low agreement in the type of change (2)
- Limited data and/or literature (2)

Confidence in human contribution to the observed change

- High
- Medium
 - Low due to limited agreement
 - Low due to limited evidence

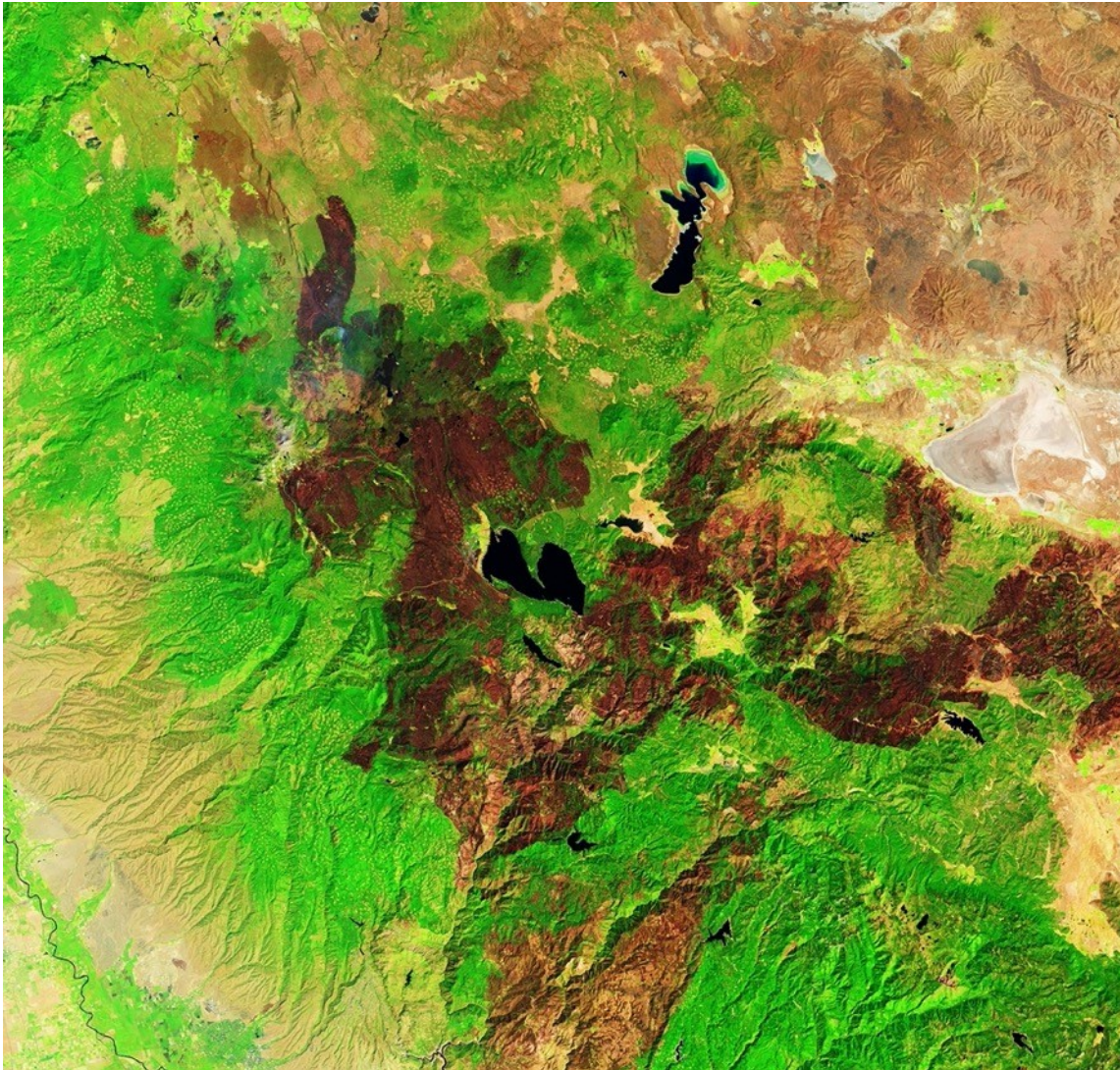


Wildfires

Twelve out of the top twenty fires in California have happened in the last 5 years.

Burned 4% of California's total land area.

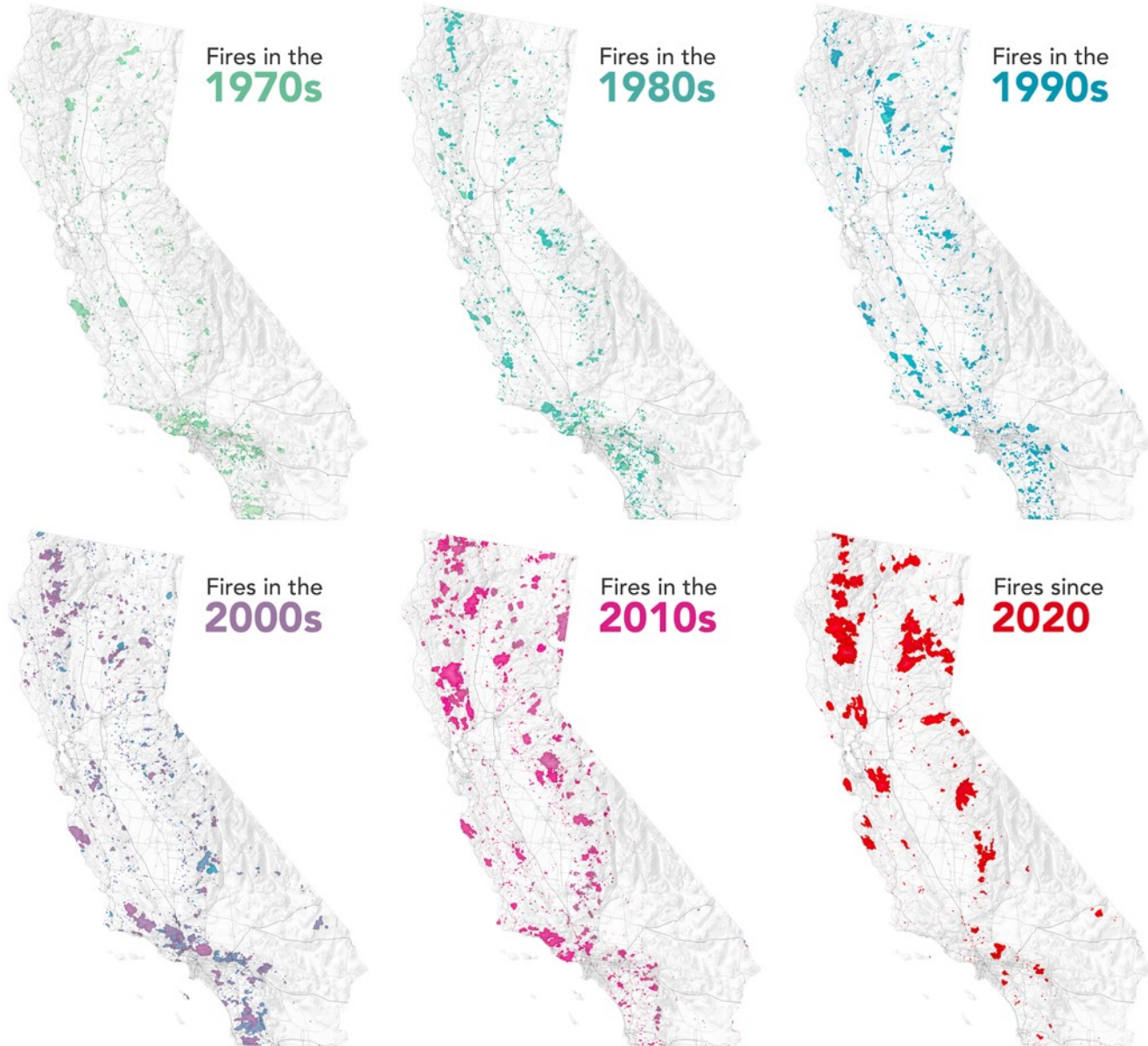
Dixie fire alone burned an area of >1 million acres.

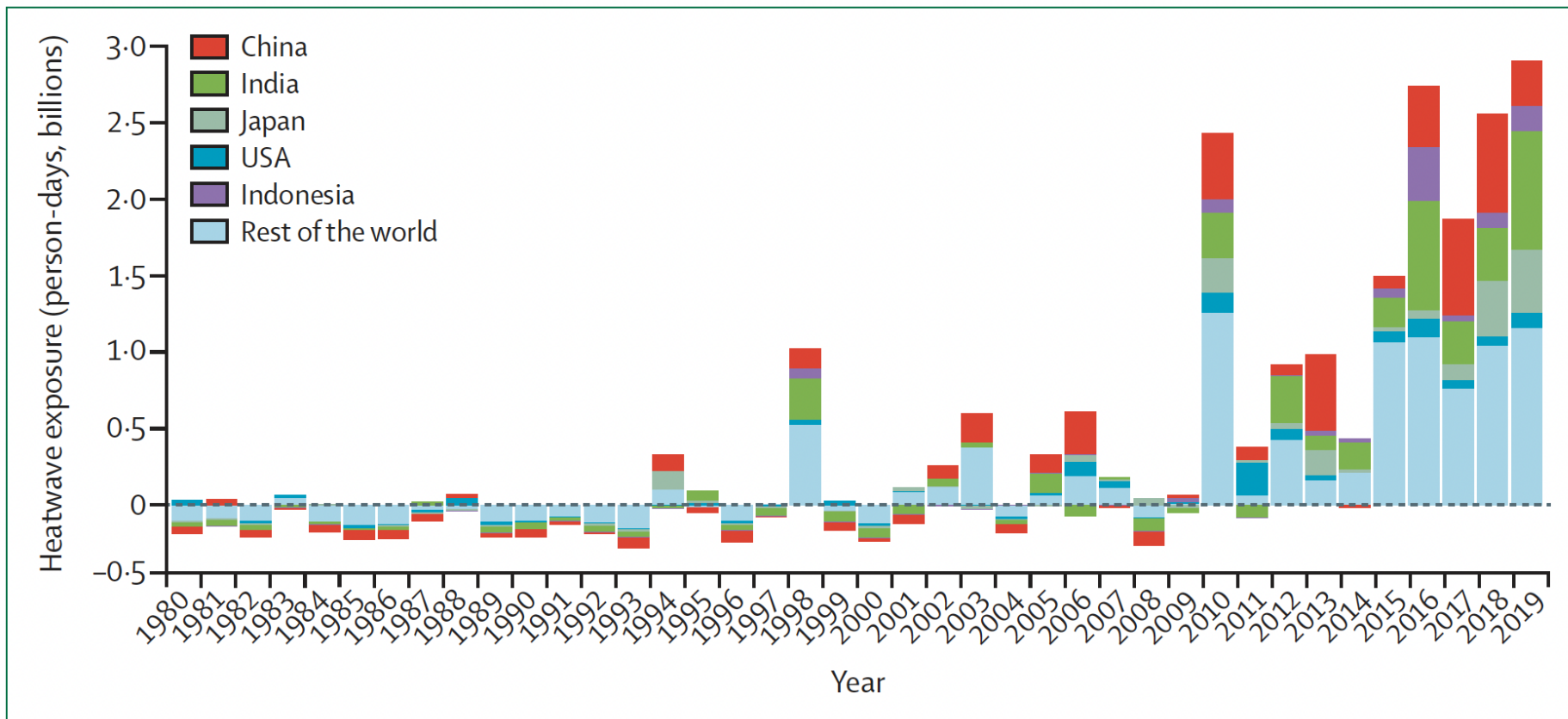


Landsat 8 image of the Dixie fire, California
(13 September 2021)

California's Wildfires are Growing

Simply put, the fires of recent years dwarf those of previous decades.





Change in the days of heatwave exposure relative to a 1986-2005 baseline for people >65 years.

Watts, N., Amann, M., Arnell, N., Ayeb-Karlsson, S., Beagley, J., Belesova, K., Boykoff, M., Byass, P., Cai, W., Campbell-Lendrum, D. and Capstick, S., 2020. The 2020 report of The Lancet Countdown on health and climate change: responding to converging crises. *The Lancet*, 397, p135.

b) Synthesis of assessment of observed change in **heavy precipitation** and confidence in human contribution to the observed changes in the world's regions

Type of observed change in heavy precipitation

● Increase (19)

● Decrease (0)

▨ Low agreement in the type of change (8)

○ Limited data and/or literature (18)

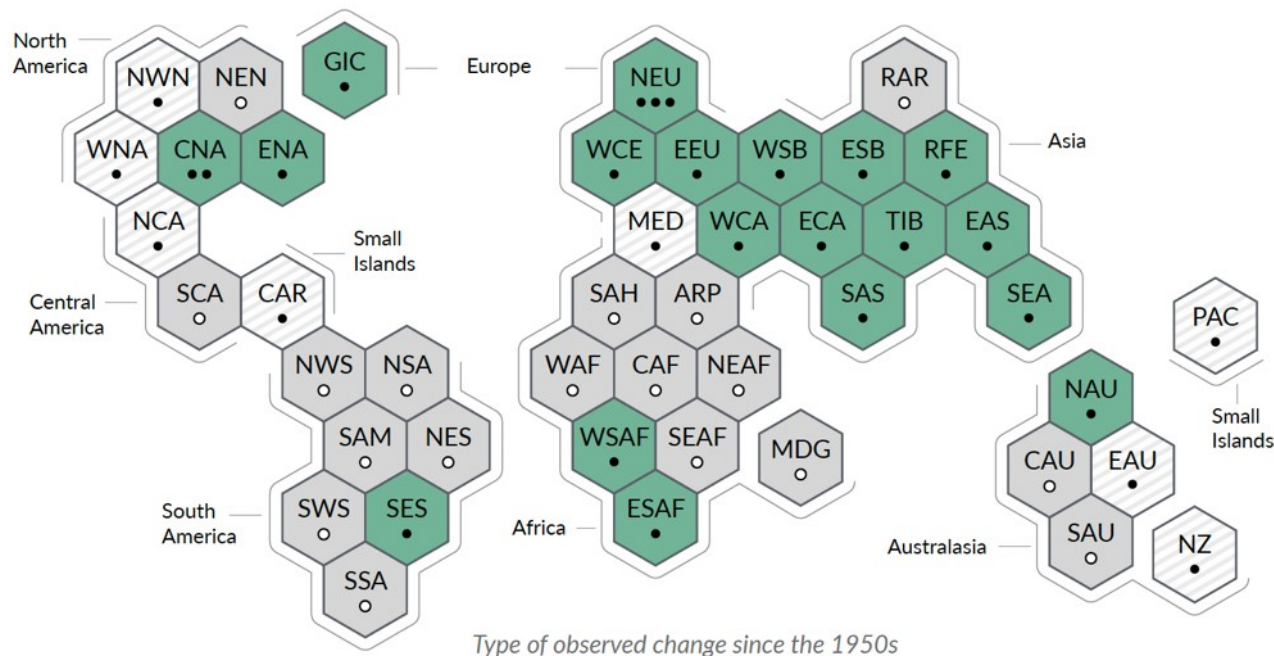
Confidence in human contribution to the observed change

●●● High

●● Medium

● Low due to limited agreement

○ Low due to limited evidence



Germany floods: Dozens killed after record rain in Germany and Belgium

15 July



The deadly floods have left homes and cars destroyed

At least 70 people have died in Germany and Belgium after record rainfall caused rivers to burst their banks.

Most of the victims were in Germany, but at least 11 have died in Belgium, with more reported missing.

BBC News (15th July) - <https://www.bbc.co.uk/news/world-europe-57846200>

Used Climate Change As Impacts Ravage The Globe

● California Records Driest Year Since 1924
Oct 19, 2021 - Climate Nexus Hot News

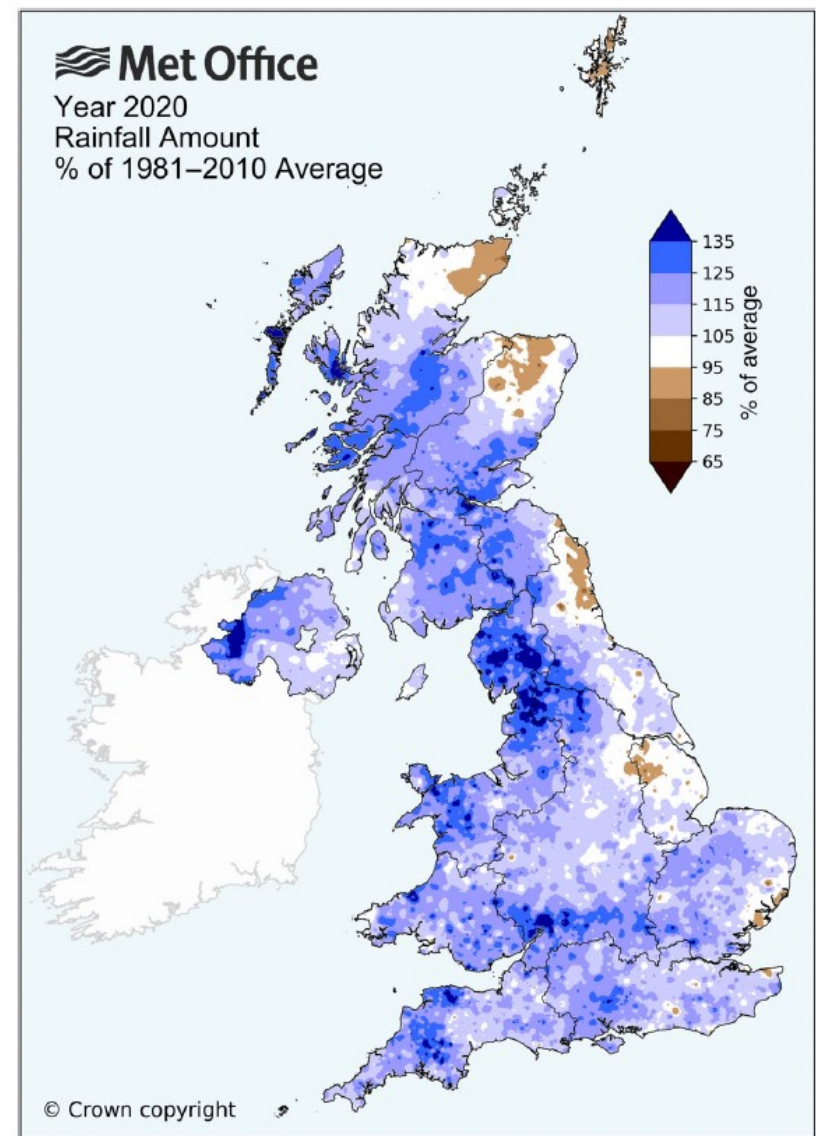
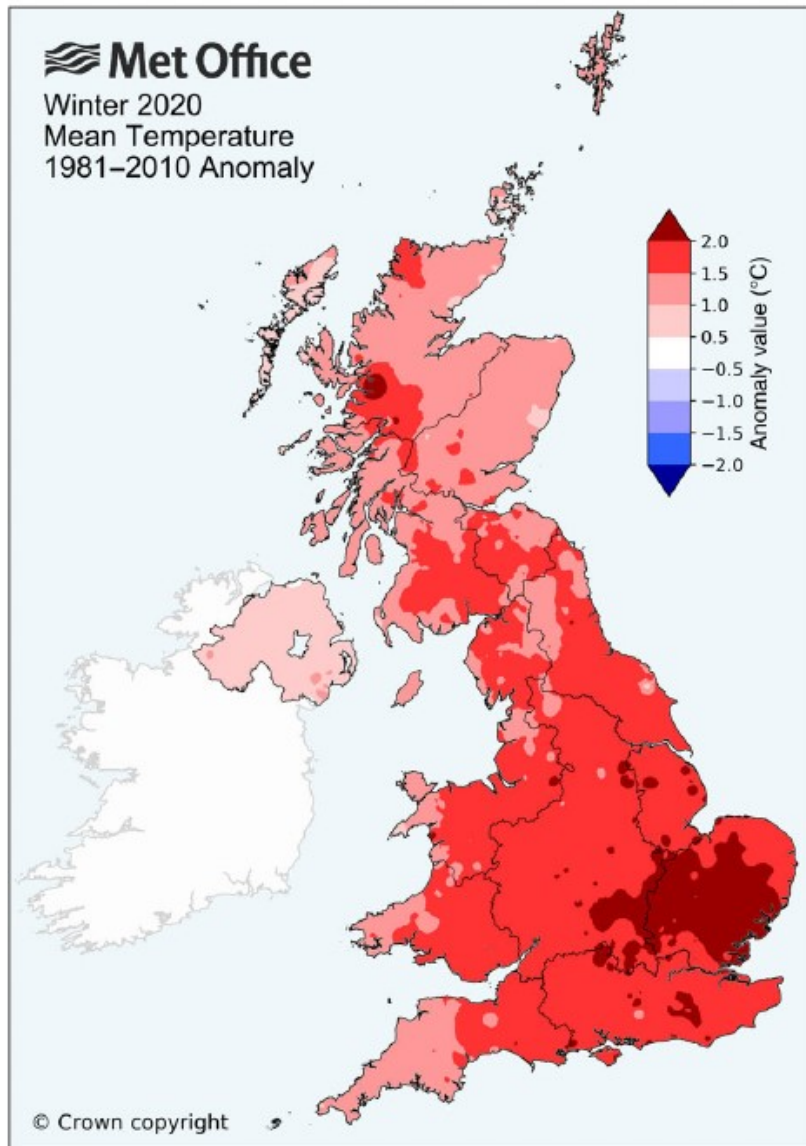
● The drought in California this summer was the worst on record
Oct 14, 2021 - CNN

● Colorado drought worsens as report says
Oct 14, 2021 - ABC 7 Denver

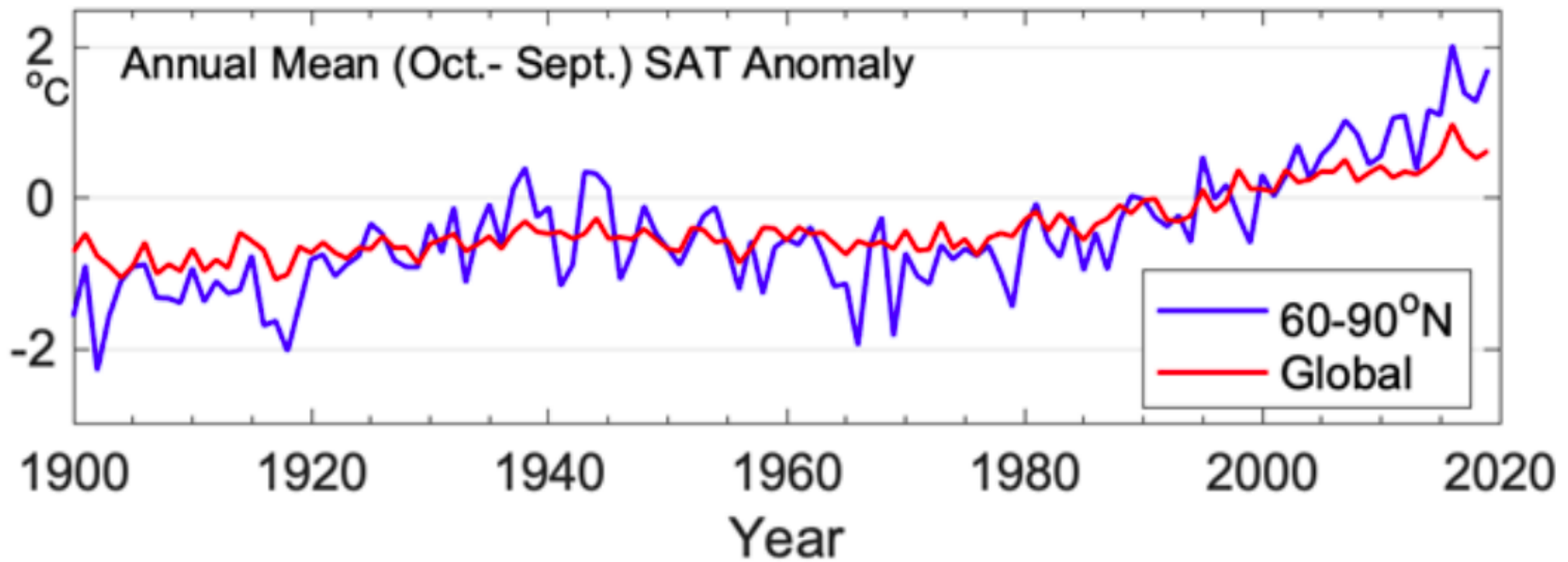


Growth in research into “climate attribution” and the connections between longer-term climate change and extreme weather events.

<https://www.climatesignals.org>



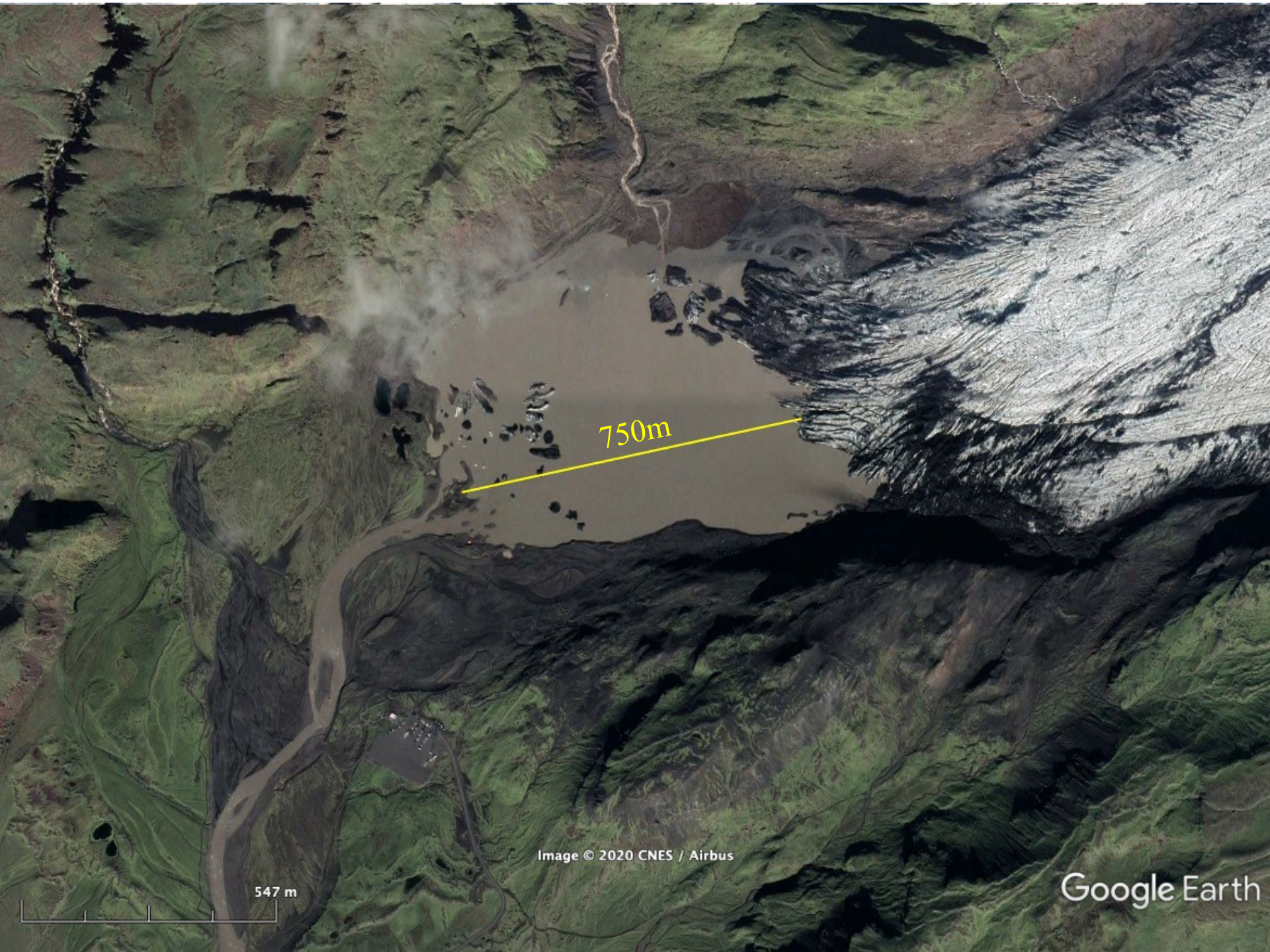
Kendon, M., McCarthy, M., Jevrejeva, S., Matthews, A., Sparks, T. and Garforth, J., 2021. State of the UK Climate 2020. *International Journal of Climatology*, 41, pp.1-76.



Change in average annual land surface temperatures between 1900-2019. Note how the rate of increase in the high latitude stations is much more rapid than the globally averaged figure.

Mean annual surface temperature for Oct 2018 – Sept 2019 was 1.9°C higher than the 1981-2010 mean.

NOAA Arctic Report Card, p6



750m

547 m

Image © 2020 CNES / Airbus

Google Earth

The glaciers of Iceland seemed eternal. Now a country mourns their loss

Andri Snær Magnason

My grandparents mapped these giants of the landscape. A plaque will mark the spot where the first was lost to the climate crisis



Aerial photographs show the melting of the Ok glacier in Iceland, from September 1986 to the beginning of August this year. Photograph: Nasa Earth Observatory/EPA

Bréf til framtíðarinnar

Ok er fyrsti nafnkunni jökullinn til að missa titil sinn.
Á næstu 200 árum er talið að allir jöklar landsins fari sömu leið.
Þetta minnismerki er til vitnis um að við vitum
hvað er að gerast og hvað þarf að gera.
Aðeins þú veist hvort við gerðum eitthvað.

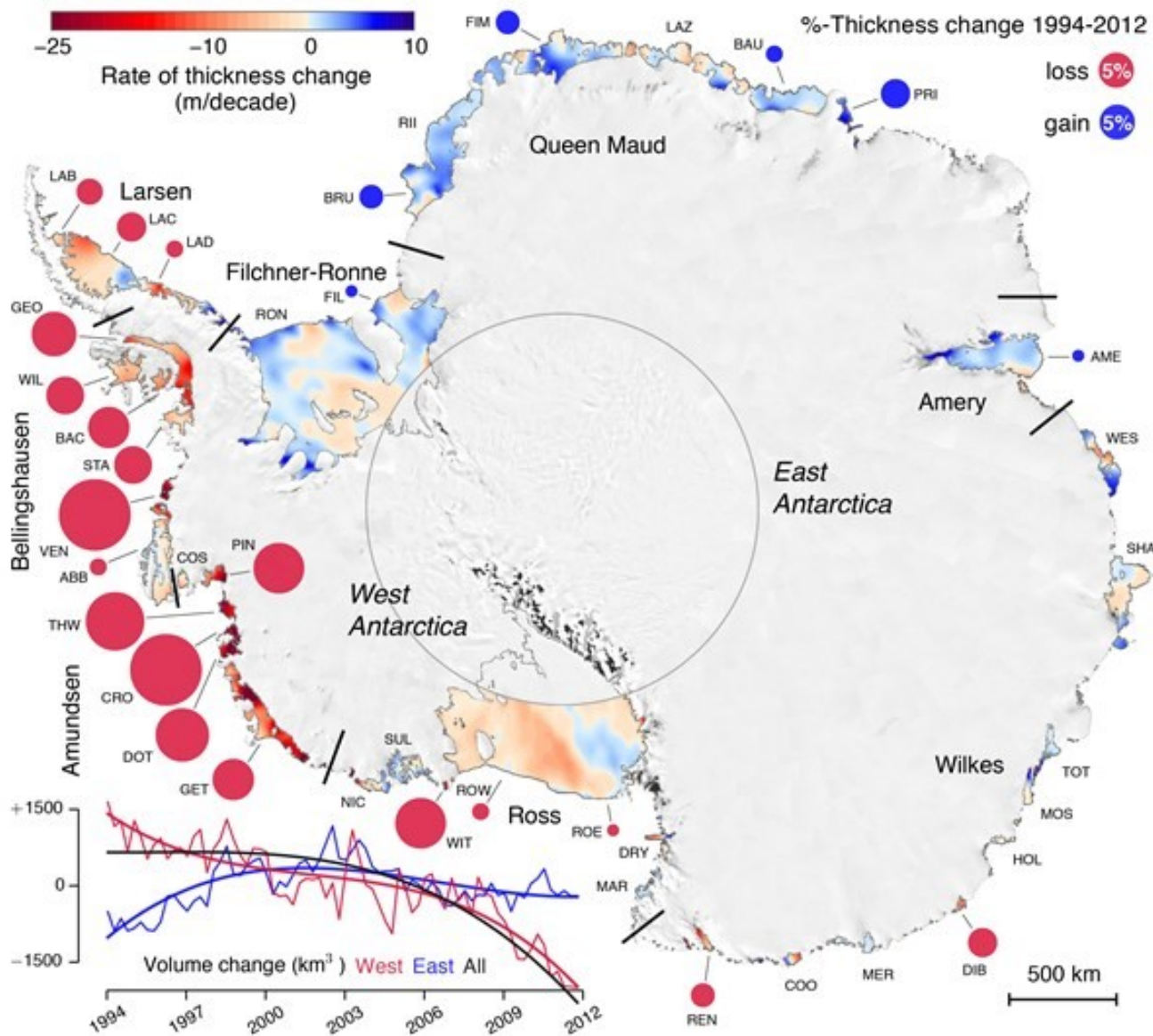
A letter to the future

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 know if we did it.

Ágúst 2019
415ppm CO₂

<https://landsat.gsfc.nasa.gov/tribute-to-a-glacier-that-is-no-more/>

<https://www.theguardian.com/commentisfree/2019/aug/14/glaciers-iceland-country-loss-plaque-climate-crisis>



Change in the thickness of ice shelves between 1994 – 2012.

Paolo, F.S. *et al.*, 2015. Volume loss from Antarctic Ice Shelves is accelerating.

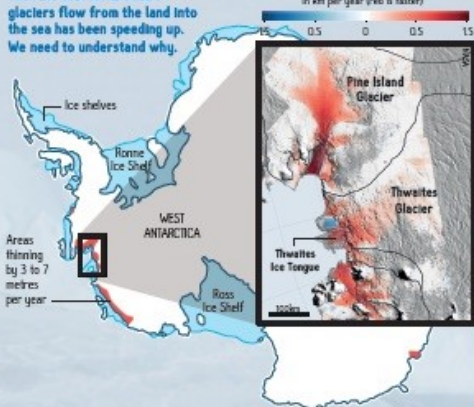
Science, 348, p328.

INVESTIGATING THWAITES GLACIER



The rate that Antarctica's glaciers flow from the land into the sea has been speeding up. We need to understand why.

Change in glacier speed from 1996 to 2008 (in km per year (red is faster))

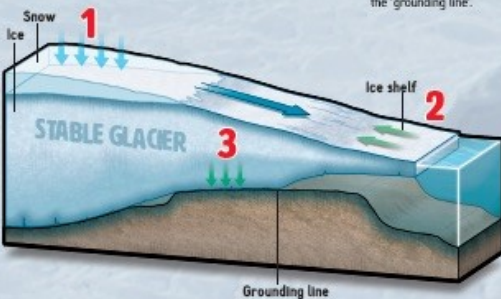


Thwaites Glacier and Pine Island Glacier are two of the biggest and fastest-retreating in Antarctica. If both collapsed, global sea levels could rise by over a metre. Without them, the entire West Antarctic Ice Sheet could be more likely to collapse, leading global sea levels to rise by over three metres.

A five-year collaboration is investigating what's causing ice loss at Thwaites Glacier and how it will impact global sea levels. This is a joint venture between the U.S. National Science Foundation and the UK's Natural Environment Research Council. The eight projects use a suite of technologies.

FROM STABLE GLACIER...

- 1 A stable glacier is in rough equilibrium. Annually, the snow falling on the glacier replaces the ice flowing into the ocean.
- 2 The floating part of a glacier, the ice shelf, acts like a cork or dam, holding back the ice upstream.
- 3 Sediments and water beneath the ice affect its speed – as does how much of the glacier is in contact with the land at the 'grounding line'.



...TO RETREATING GLACIER

- 4 The equilibrium of the stable glacier is lost. There is no longer enough snowfall to replace the increasing ice flow into the ocean. All the lost ice ends up in the ocean, raising global sea level.
- 5 Warm currents under the ice increase, melting the floating ice shelf and causing more icebergs.
- 6 The thinning reduces its effectiveness in damming ice flow.
- 7 As more of the glacier begins to float the glacier flows faster.



RADAR

NERC's Twin Otter aircraft will take radar measurements to look deep below the surface of the ice and build a clear picture of how different layers of ice and the bedrock interact. This is crucial in understanding how climate change will affect large ice sheets.



SEISMOMETERS

An array of seismometers will measure conditions under the ice and detect changes in movement, in the same way we monitor earthquakes.



HOT WATER DRILLS

These sample the seabed beneath floating ice shelves and sediments beneath grounded ice. They also take ice cores from the ice shelf, which will show us what the climate was like in the past.

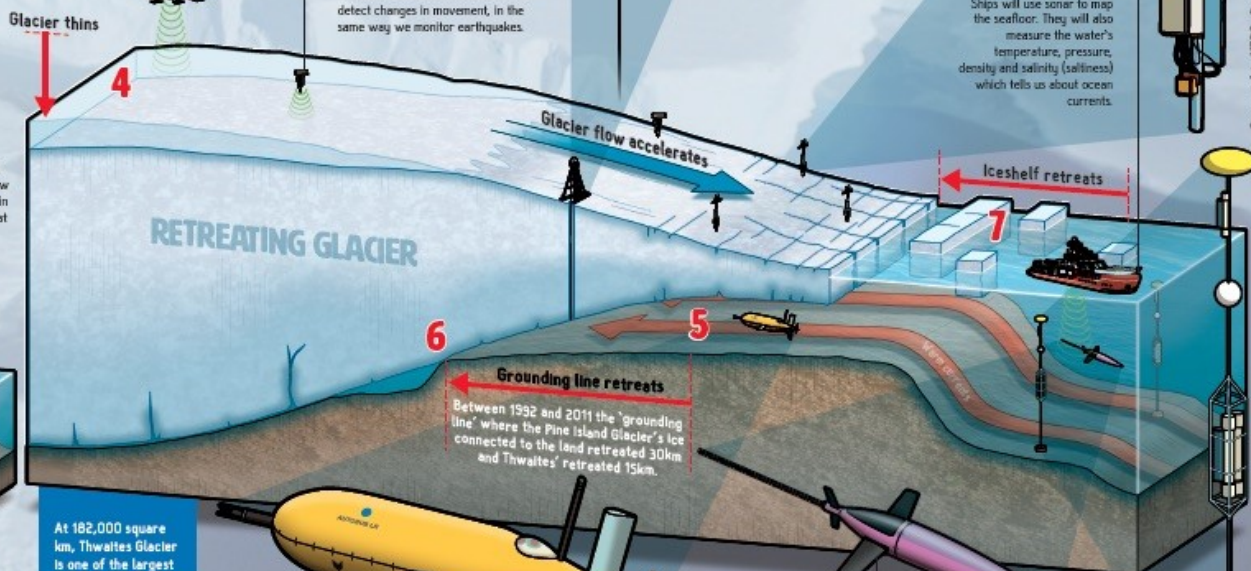


REMOTE STATIONS

Multi-sensor remote autonomous stations will measure weather, ice conditions, ocean currents and temperature from on top of the ice shelf or on sea ice.

SHIPS

Ships will use sonar to map the seafloor. They will also measure the water's temperature, pressure, density and salinity (saltiness) which tells us about ocean currents.



At 182,000 square km, Thwaites Glacier is one of the largest glaciers on the planet. It covers an area the size of Great Britain or the State of Florida. It is so remote that only a very few human beings have ever set foot on it.

SUBS

Autonomous underwater vehicles travel deep beneath the ice shelf to investigate cavities under the ice shelf and how a warmer ocean affects them.

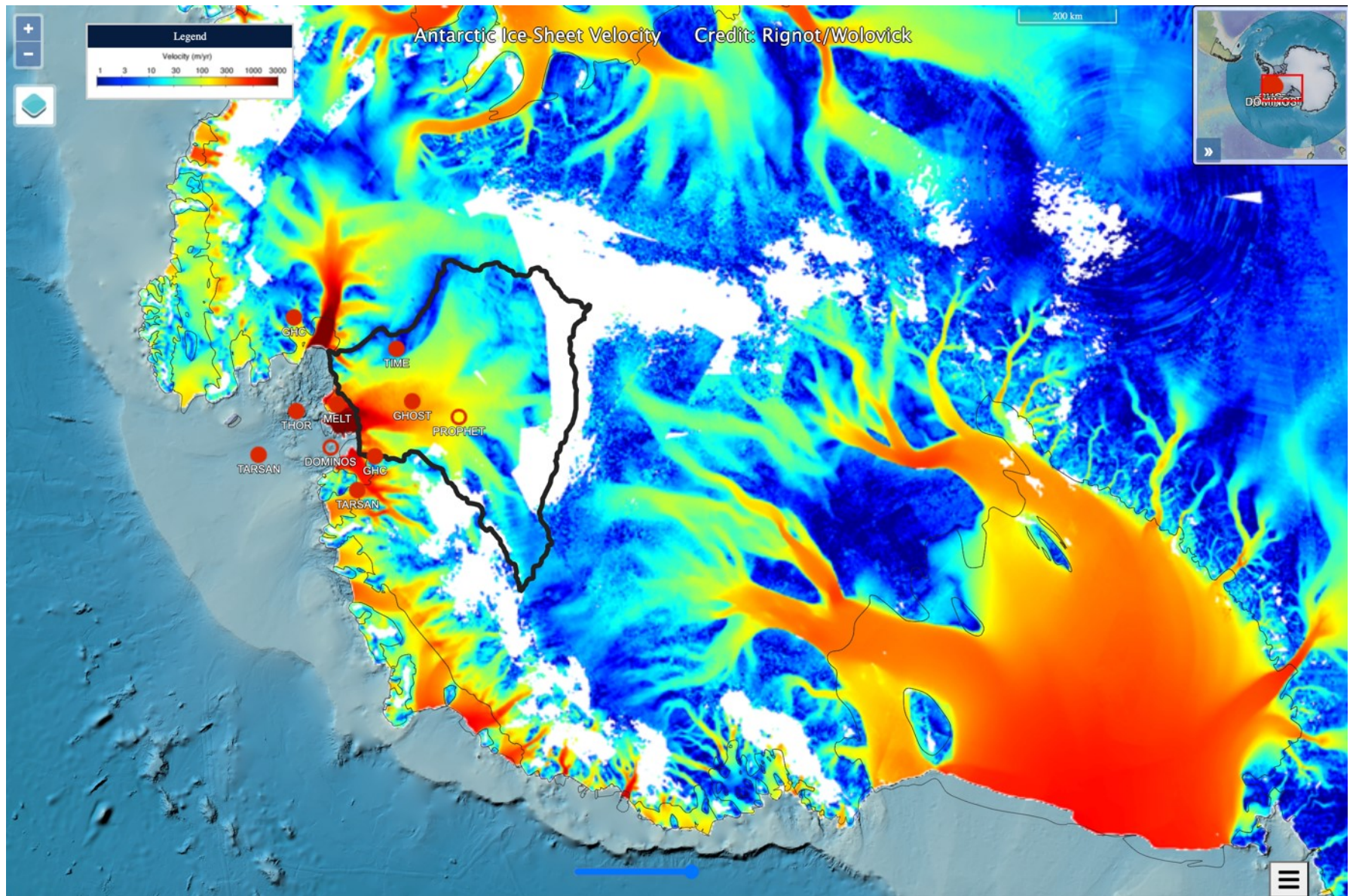
OCEAN GLIDERS

Glidors are underwater robots that use changes in buoyancy to move through the water instead of motors. These will investigate ocean currents by measuring temperature, pressure, density and salinity.

OCEAN MOORINGS

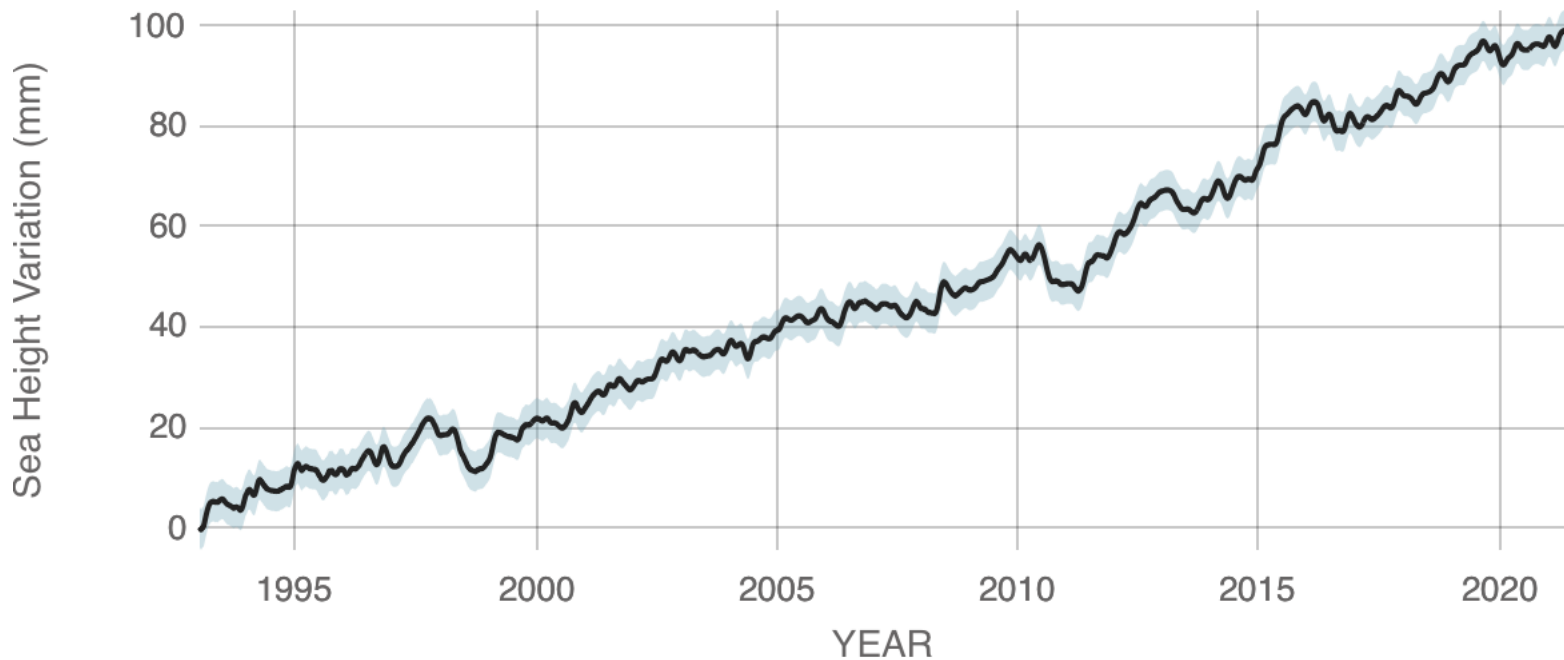
A suite of sensors anchored to the sea floor and supported by floats monitoring water temperature, salinity and density – as well as changes in conditions beneath the glacier.

Copyright: NERC, Ben Gilliland



Acceleration of the glacier margin to $>3\text{km/yr}$ leading to an estimated ice loss of 125 billion tons per year.

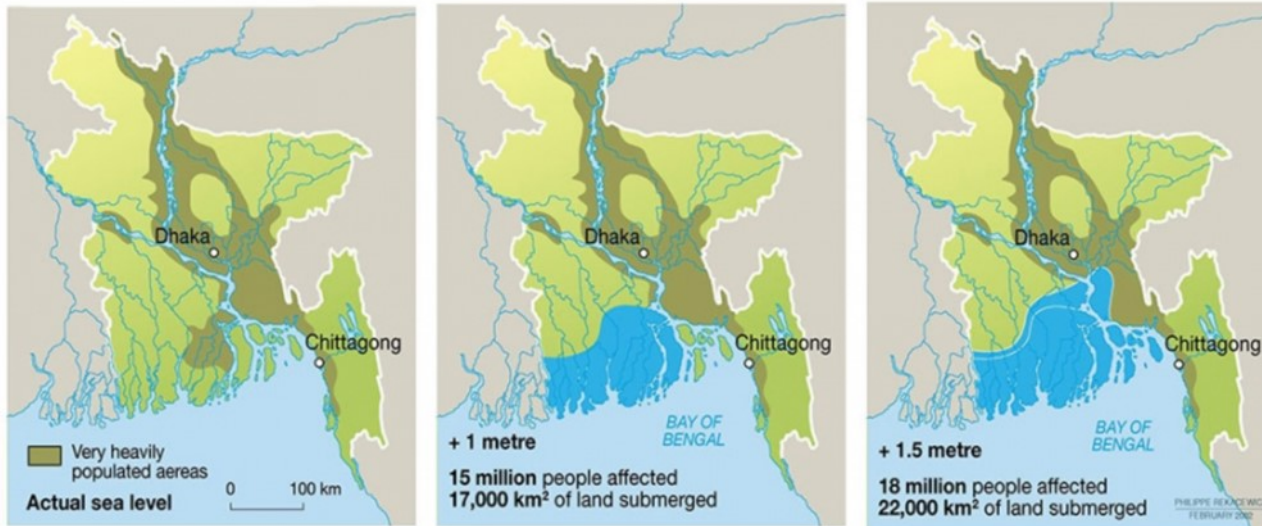
<https://www.thwaites-explorer.org/>



Source: climate.nasa.gov

“Global sea levels are rising as a result of human-caused global warming, with recent rates being unprecedented over the past 2,000-plus years.”

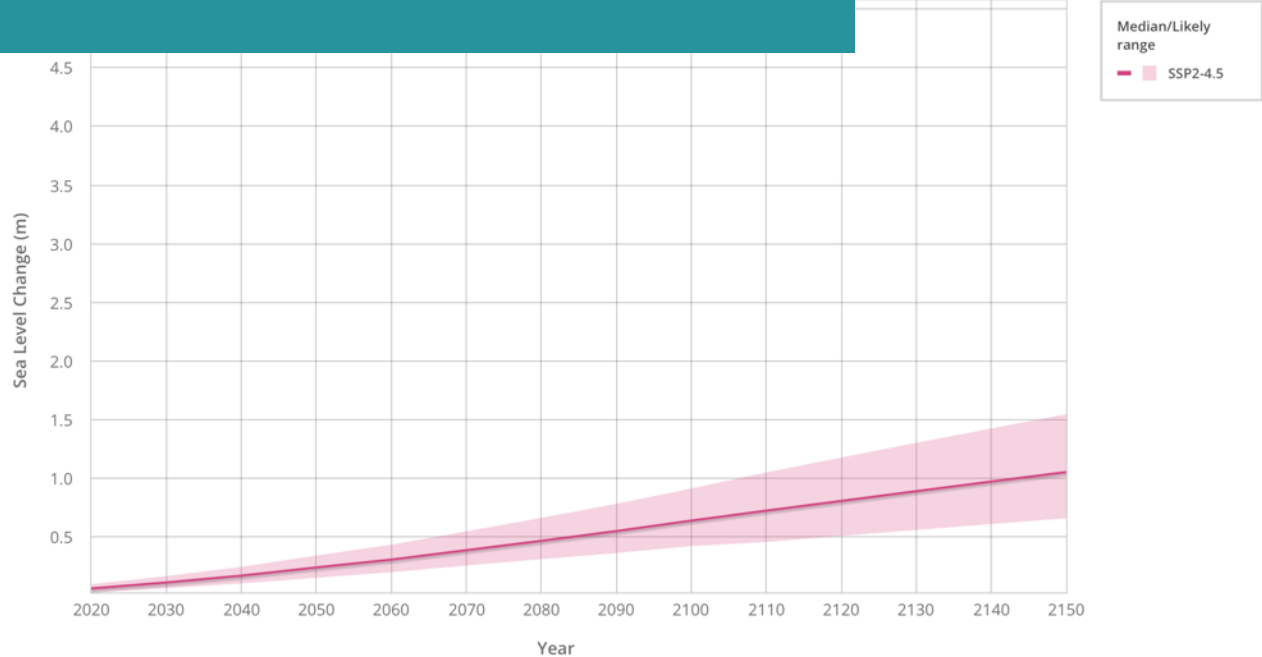
<https://climate.nasa.gov/vital-signs/sea-level/>



Sources: Dacca University; Intergovernmental Panel on Climate Change (IPCC).

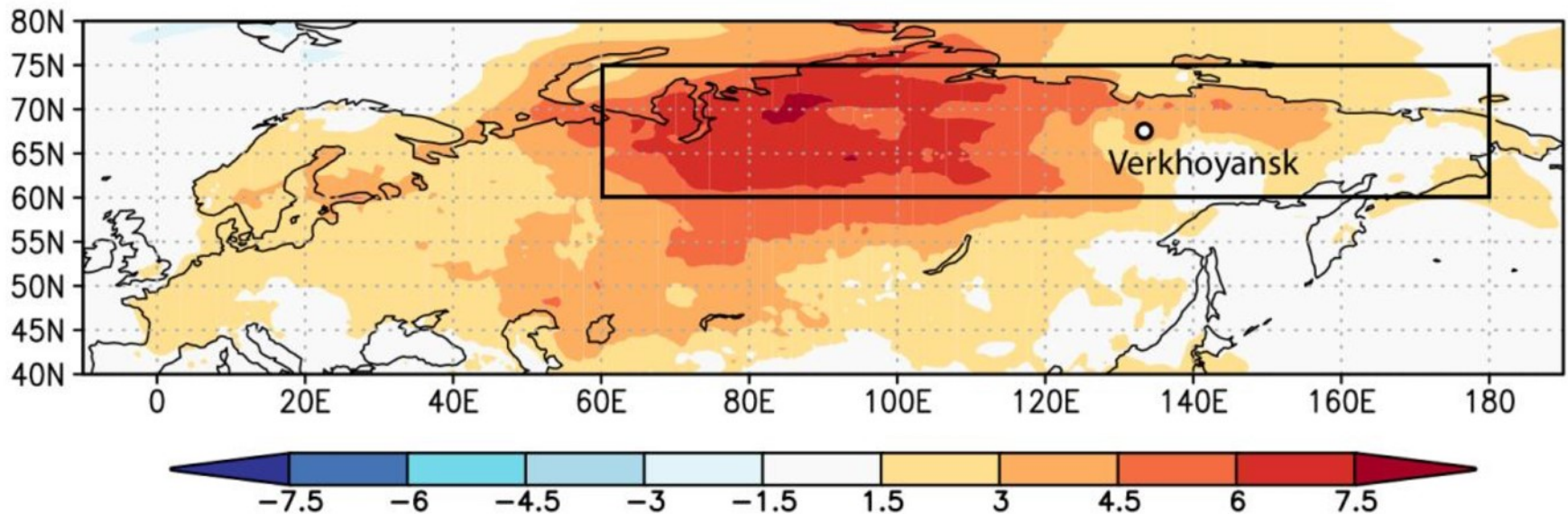
[https://scied.ucar.edu/
image/sea-level-
change-bangladesh](https://scied.ucar.edu/image/sea-level-change-bangladesh)

Credit: Phillipe Rekacewicz, GRID Arendal



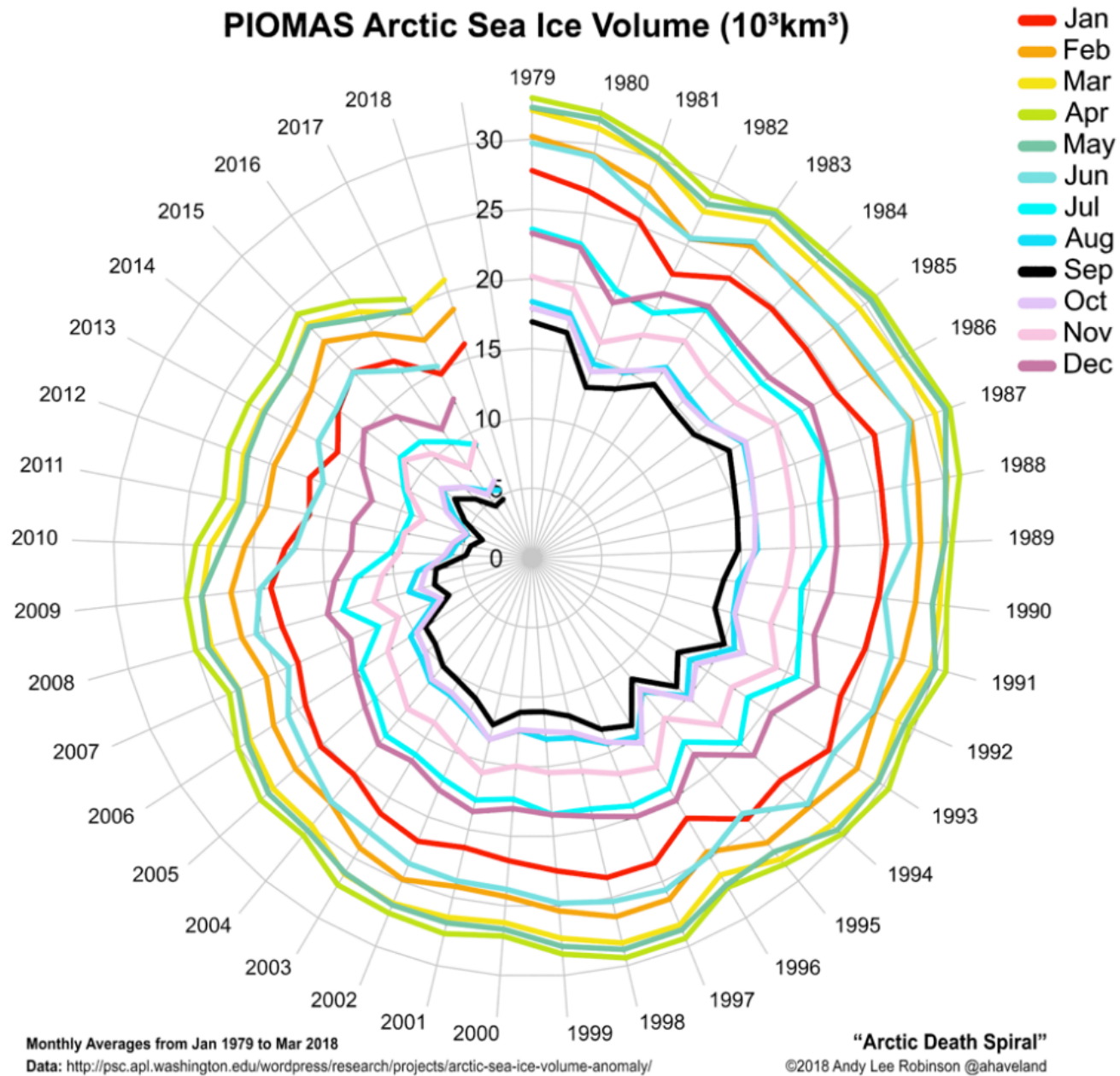
[https://sealevel.nasa.
gov/ipcc-ar6-sea-
level-projection-
tool?psmsl_id=1451](https://sealevel.nasa.gov/ipcc-ar6-sea-level-projection-tool?psmsl_id=1451)

Record breaking Arctic Temperatures



- Early summer 2020 – first time temperatures of $>100^{\circ}\text{F}$ (38°C) have been recorded in the Arctic.
- Average temperatures in the first half of the year 6°C higher than normal (1981-2010).
- Considered directly attributable to climate change.

<https://www.worldweatherattribution.org/siberian-heatwave-of-2020-almost-impossible-without-climate-change/>



<https://haveland.com/share/arctic-death-spiral.png>



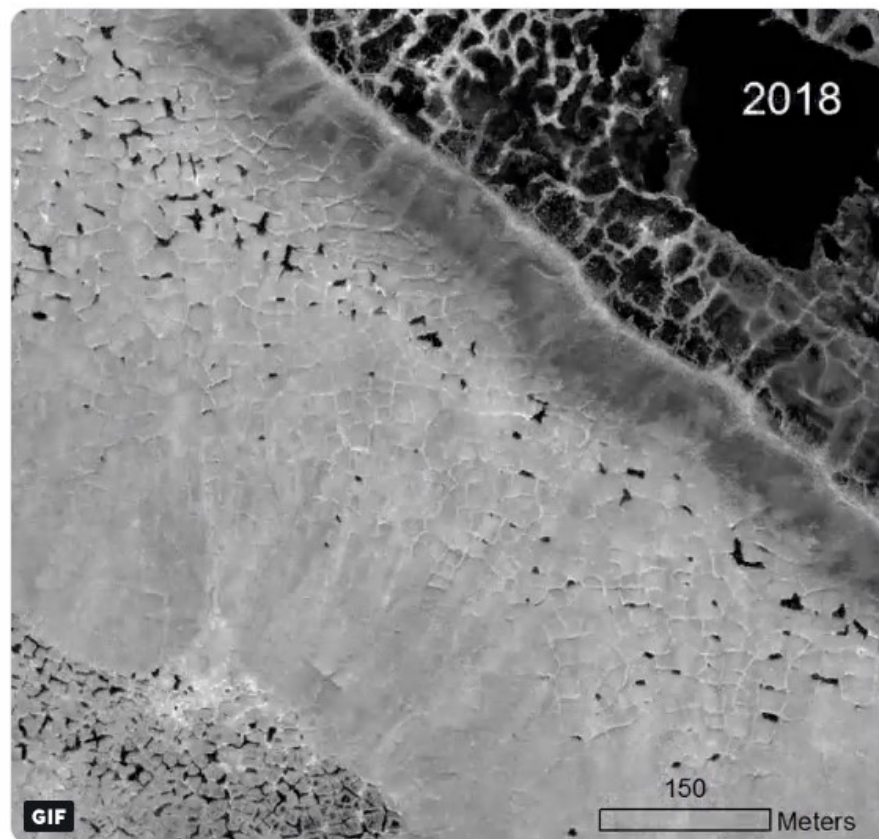
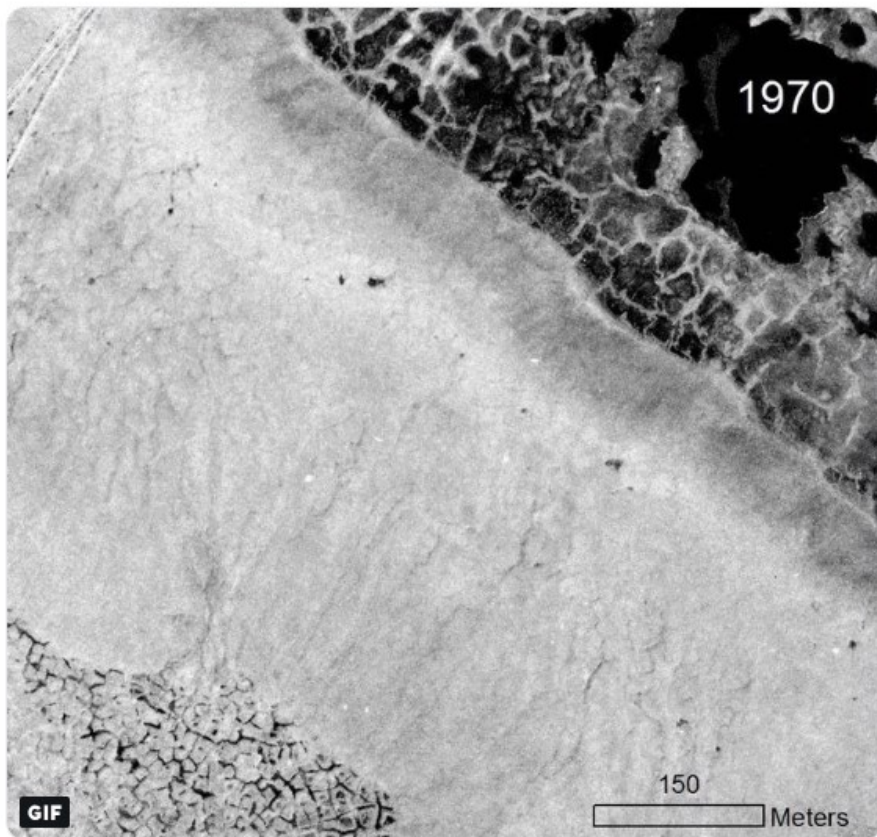
Robert H Fraser

@EOArctic

Follow



Expansion of melt ponds due to the degradation of ice-wedge polygons (thermokarst) since 1970 in uplands of the Yukon Coastal Plain.



8:02 PM - 25 Jan 2019

39 Retweets 70 Likes



39



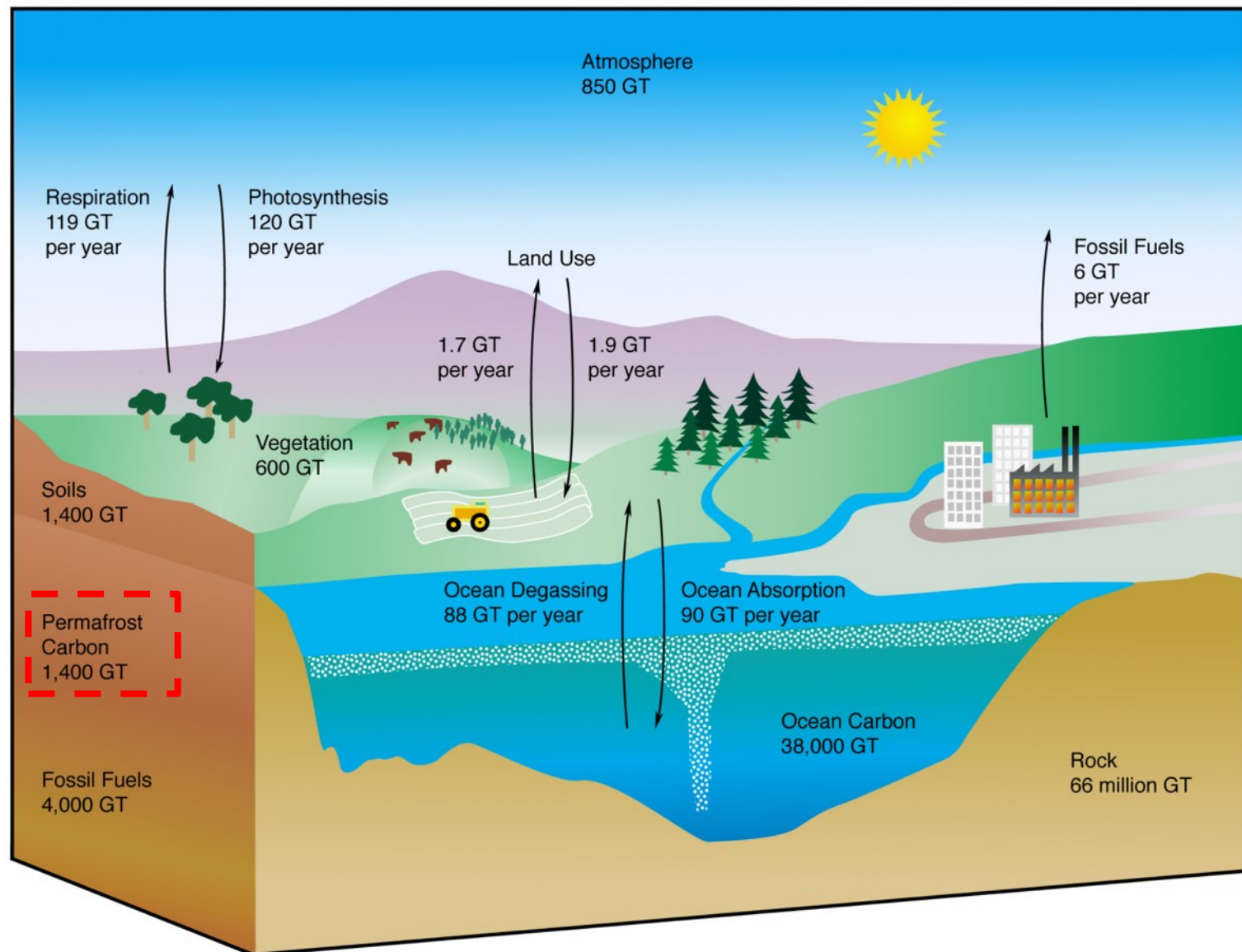
70



<https://twitter.com/EOArctic/status/1088889768417640448>



Conservative estimates suggest that 136,000 km² of this study area is affected by these landscape disturbances with their extent increasing rapidly over time.



Global carbon stores and fluxes: Note how much carbon is estimated to be stored in permafrost alone - more than the carbon currently in the atmosphere.

<https://nsidc.org/cryosphere/frozenground/methane.html>



Arctic Lake Methane Ignited by Katey Walter Anthony

39,864 views • 17 Dec 2009

👍 132 🗨️ 8 ➦ SHARE ⚙️ SAVE ⋮

<http://www.youtube.com/watch?v=Wofv9o0j1Ew>



3. Carbon Budgets & COP 26



UN CLIMATE
CHANGE
CONFERENCE
UK 2021

EN / IT

UK PRESIDENCY ^

THE CONFERENCE v

PRE-COP v

NEWS

TOGETHER FOR OUR PLANET

INTRODUCTION

WHAT IS A COP?

THE ROAD TO COP26

UK CLIMATE LEADERSHIP

NEGOTIATIONS

CAMPAIGNS

OUR TEAM

FRIENDS OF COP

SPONSORS

CLIMATE & DEVELOPMENT MINISTERIAL

01-12 NOV 2021

GLASGOW

COP26

IN PARTNERSHIP WITH ITALY



<https://ukcop26.org>

Warming is 'biggest world threat'

Paul Brown

Climate change is a more serious threat to the world than terrorism, David King, the government's chief scientist, writes in an article in today's Science magazine, attacking governments for doing too little to combat global warming.

He particularly attacks the United States for "refusing to countenance any remedial action now or in the future" to curb its own greenhouse gases, which are 20% of the world's total, even though it has only 4% of the population.

Disclosing that he had commissioned a team of scientists and engineers to find ways of reducing the severe damage the UK faces from climate change, he says the potential damage to property runs into

"10s of billions of pounds per annum."

Britain is doing its bit to reduce emissions, but acting alone is not enough, he says. "We and the rest of the world are now looking to the USA to play its leading part."

As an example of what his team is discussing, he says Britain's coastal defences will be subject to attack from both increased sea level rises and greater storm surges.

"These combined efforts have the potential to increase risk of floods in 2080 by up to 30 times present levels. In the highest emission scenario, by 2080 flood levels that are now expected once in 100 years could be recurring every 3 years. People at high risk of flooding in Britain will double to nearly 3.5 million."

If no work is done coastal erosion in Britain will increase nine-fold, he adds.

Urging action to reduce carbon dioxide emissions at once he comments: "Delaying action for decades, or even just years, is not a serious option. I am firmly convinced that if we do not stop now, more substantial, more disruptive, and more expensive change will be needed later on."

He says estimated cost of tackling climate change is around 1% of gross domestic product (GDP) for developed

'Delaying action for decades, or even just years is not a serious option'

countries like the UK. This figure could be offset by the risks associated with doing nothing.

For example, if just one flood broke through the Thames Barrier it would cost around £30bn in damage to London, roughly 2% of GDP.

Taking action to combat climate change can create economic opportunities and improve living standards. A new round of negotiations is about to begin on how to tackle climate change beyond 2008-12, when the existing Kyoto agreement on reducing emissions is due to end.

He urges both the US and developing countries to get involved "in what is a truly global problem".

"Climate change is no respecter of national boundaries," he adds.

The Guardian, 9 January 2004

Science & Environment

COP21: Paris climate deal is 'best chance to save planet'

13 December 2015 | Science & Environment | 945

Top Stories

Rise in newborns 'taken into care'

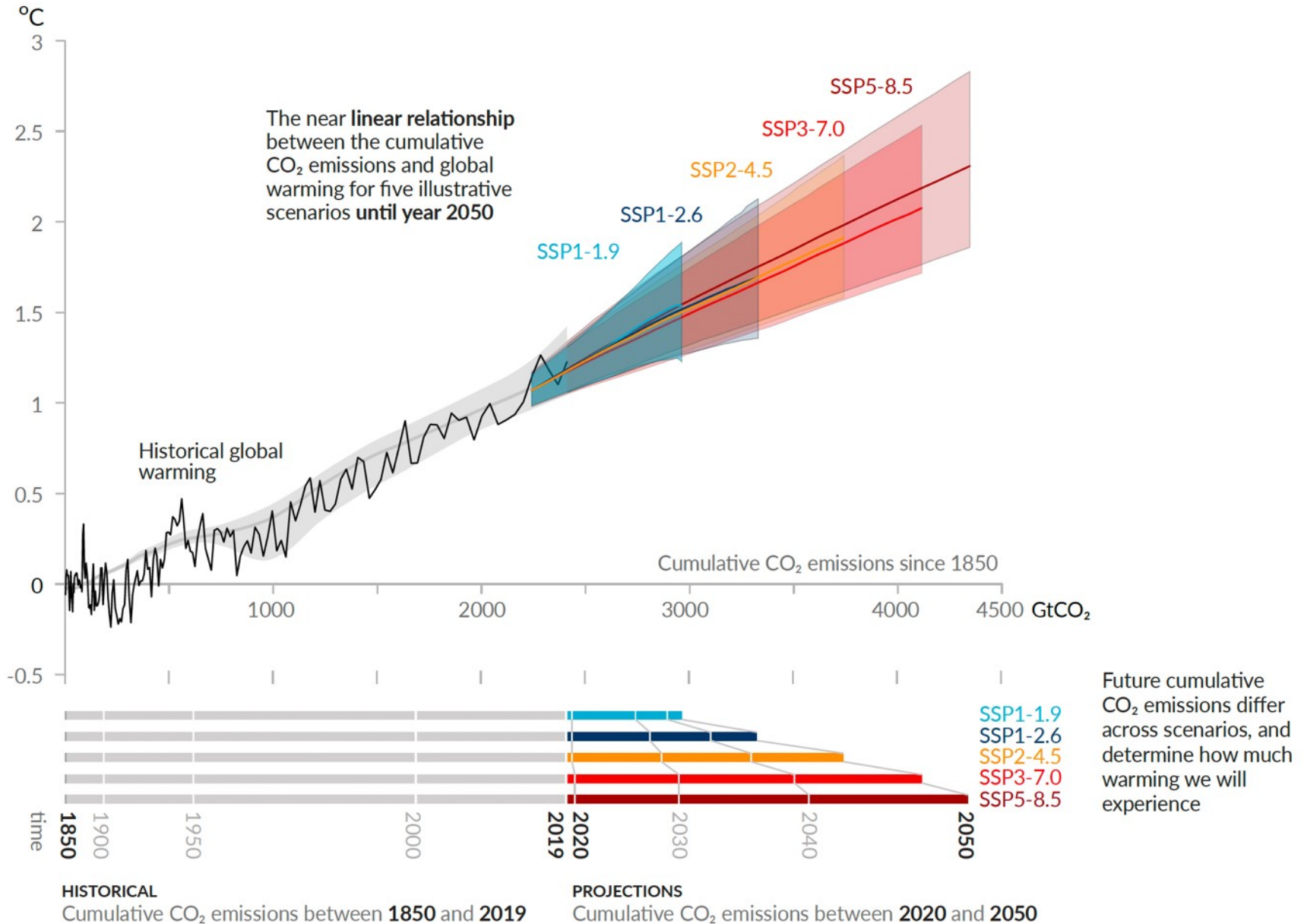
There has been a "huge increase" in the number of newborn babies who are subject to care proceedings in England, newly-compiled figures show.

What are the key elements?

- To keep global temperatures "well below" 2.0C (3.6F) and "endeavour to limit" them even more, to 1.5C
- To limit the amount of greenhouse gases emitted by human activity to the same levels that trees, soil and oceans can absorb naturally, beginning at some point between 2050 and 2100
- To review each country's contribution to cutting emissions every five years so they scale up to the challenge
- For rich countries to help poorer nations by providing "climate finance" to adapt to climate change and switch to renewable energy.

Every tonne of CO₂ emissions adds to global warming

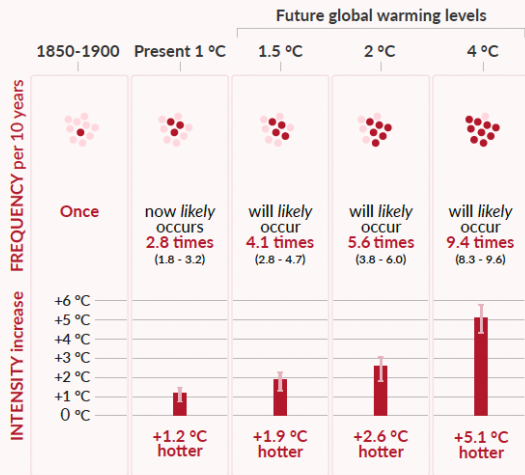
Global surface temperature increase since 1850-1900 (°C) as a function of cumulative CO₂ emissions (GtCO₂)



Hot temperature extremes over land

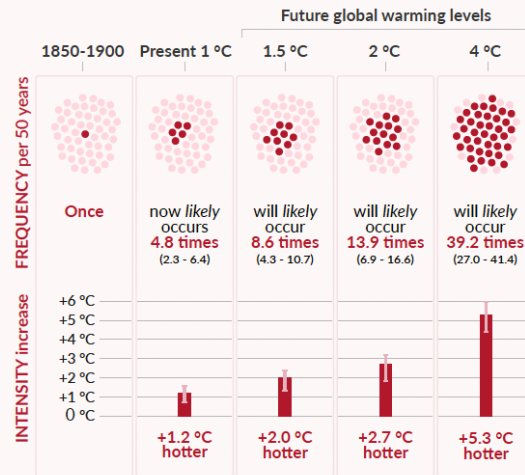
10-year event

Frequency and increase in intensity of extreme temperature event that occurred **once in 10 years** on average in a climate without human influence



50-year event

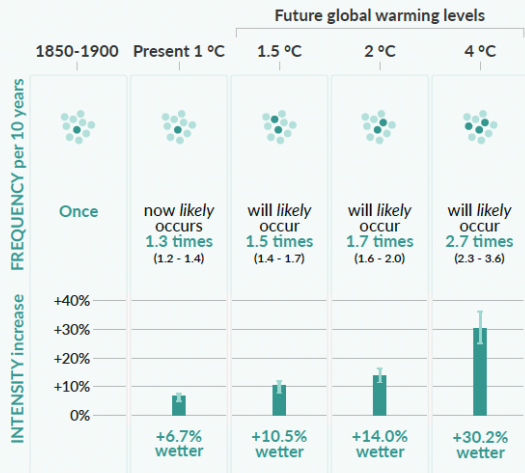
Frequency and increase in intensity of extreme temperature event that occurred **once in 50 years** on average in a climate without human influence



Heavy precipitation over land

10-year event

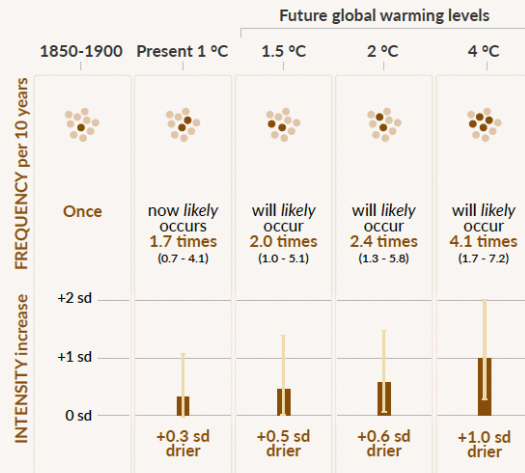
Frequency and increase in intensity of heavy 1-day precipitation event that occurred **once in 10 years** on average in a climate without human influence



Agricultural & ecological droughts in drying regions

10-year event

Frequency and increase in intensity of an agricultural and ecological drought event that occurred **once in 10 years** on average across drying regions in a climate without human influence

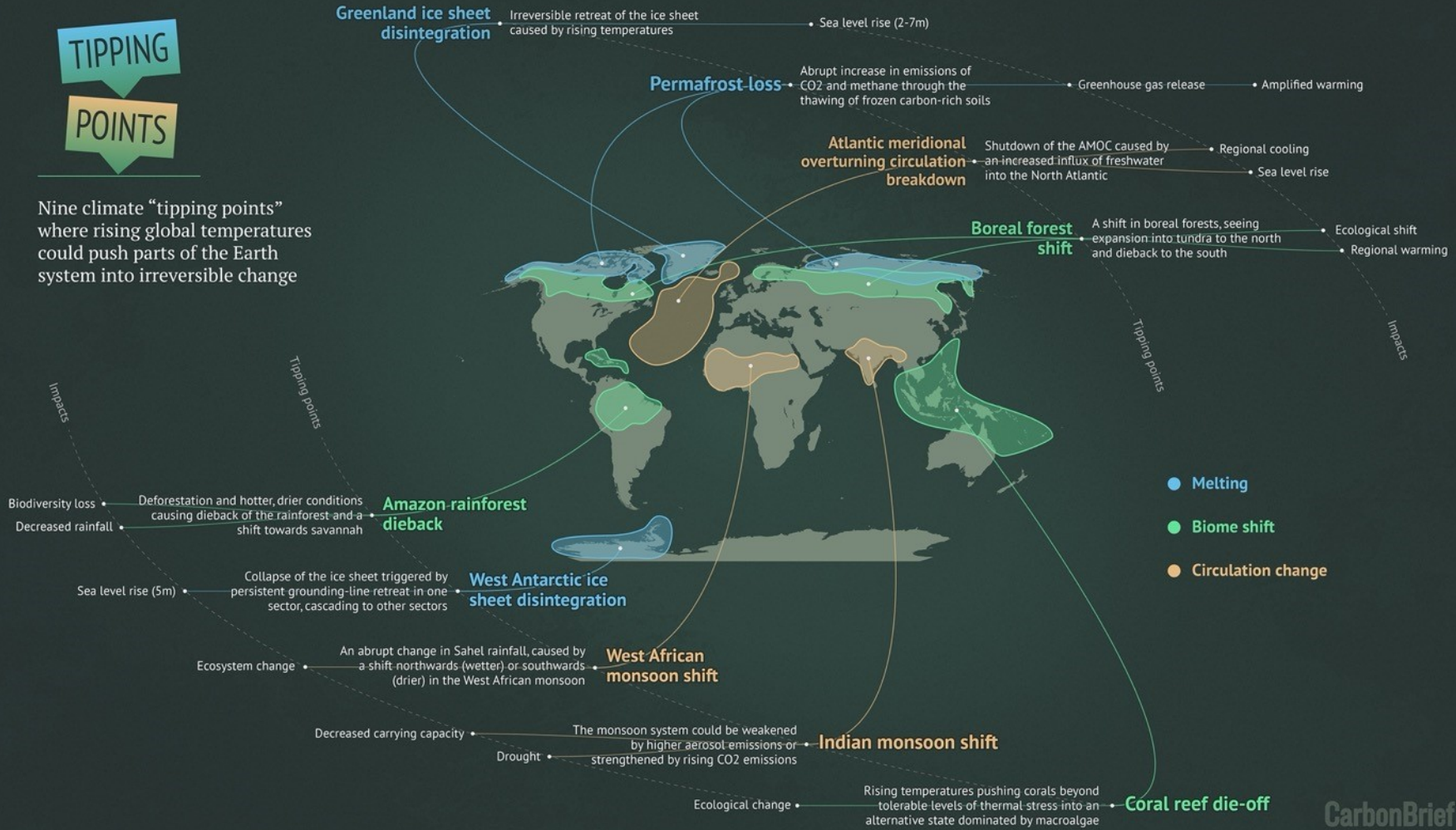


Severity of the impacts of climate change increase proportionately with the increase in temperature

Climate Change 2021: The Physical Science Basis (IPCC AR6 WR1, SPM-23)

TIPPING POINTS

Nine climate “tipping points” where rising global temperatures could push parts of the Earth system into irreversible change



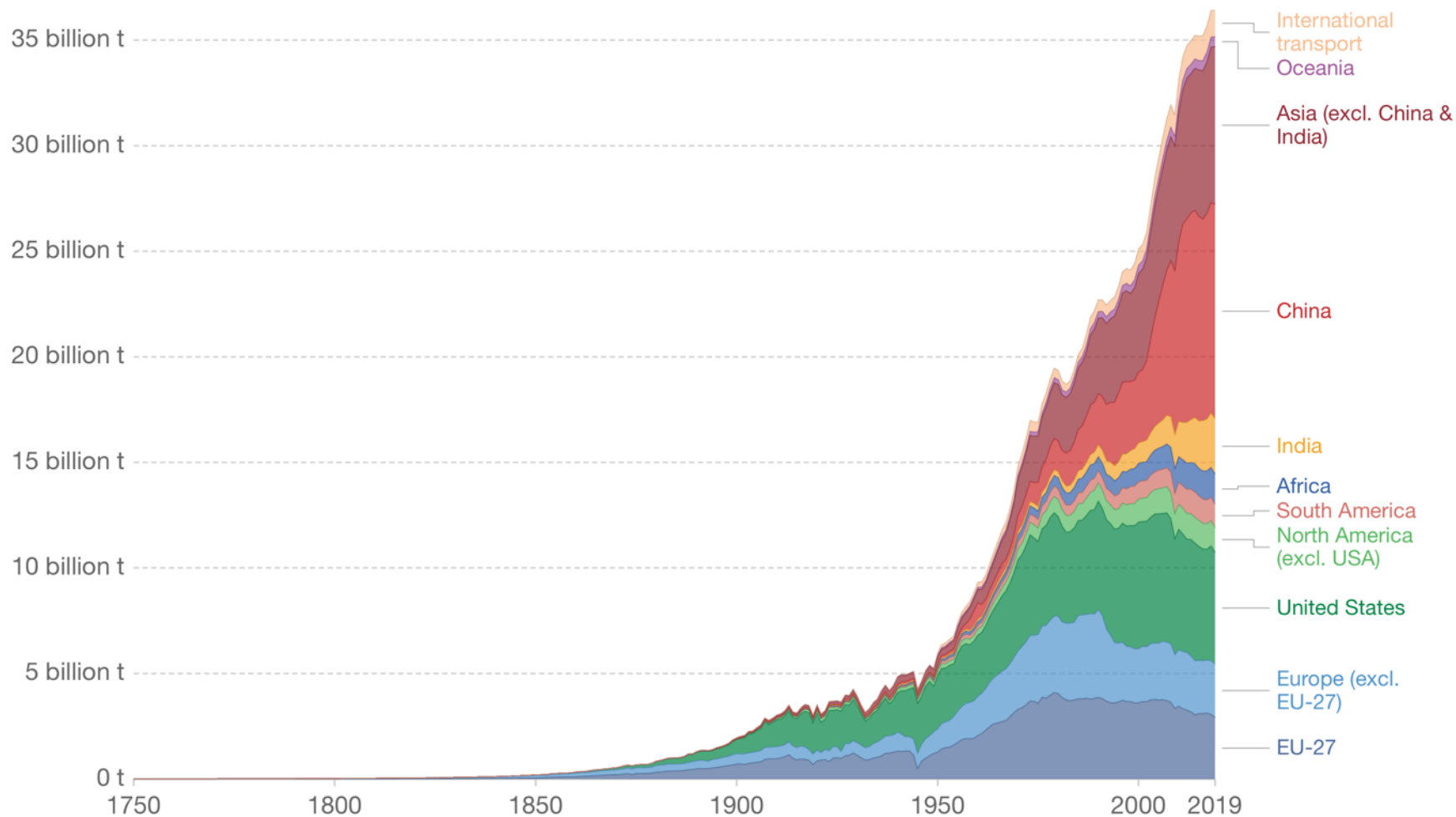
<https://www.carbonbrief.org/explainer-nine-tipping-points-that-could-be-triggered-by-climate-change>

Global warming between 1850–1900 and 2010–2019 (°C)	Historical cumulative CO ₂ emissions from 1850 to 2019 (GtCO ₂)
1.07 (0.8–1.3; <i>likely</i> range)	2390 (± 240; <i>likely</i> range)

Approximate global warming relative to 1850–1900 until temperature limit (°C)* ⁽¹⁾	Additional global warming relative to 2010–2019 until temperature limit (°C)	Estimated remaining carbon budgets from the beginning of 2020 (GtCO ₂)					Variations in reductions in non-CO ₂ emissions* ⁽³⁾
		<i>Likelihood of limiting global warming to temperature limit*⁽²⁾</i>					
		17%	33%	50%	67%	83%	
1.5	0.43	900	650	500	400	300	Higher or lower reductions in accompanying non-CO ₂ emissions can increase or decrease the values on the left by 220 GtCO ₂ or more
1.7	0.63	1450	1050	850	700	550	
2.0	0.93	2300	1700	1350	1150	900	

Climate Change 2021: The Physical Science Basis
(IPCC AR6 WR1, SPM-38)

Annual total CO₂ emissions, by world region



Source: Our World in Data based on the Global Carbon Project

OurWorldInData.org/co2-and-other-greenhouse-gas-emissions • CC BY

Note: This measures CO₂ emissions from fossil fuels and cement production only – land use change is not included. 'Statistical differences' (included in the GCP dataset) are not included here.

<https://ourworldindata.org/co2-and-other-greenhouse-gas-emissions>



Greenhouse gas emissions

Damian Carrington
Environment editor

🐦 @dpcarrington

Mon 25 Oct 2021 10.00 BST



Climate crisis: greenhouse gas levels hit new record despite lockdowns, UN reports

The data send a 'stark' message to the nations tasked with increasing action at the Cop26 climate summit, UN meteorology chief says



▲ The concentration of carbon dioxide, the most important greenhouse gas, is now 50% higher than before the Industrial Revolution. Photograph: sturti/Getty Images

Levels of climate-heating gases in the atmosphere hit record levels in 2020, despite coronavirus-related lockdowns, the UN's World Meteorological Organization has announced.

The concentration of carbon dioxide, the most important greenhouse gas, is now 50% higher than before the Industrial Revolution sparked the mass burning of fossil fuels. Methane levels have more than doubled since 1750. All key greenhouse gases (GHG) rose faster in 2020 than the average for the previous decade and this trend has continued in 2021, [the WMO report](#) found.

Global greenhouse gas emissions and warming scenarios

- Each pathway comes with uncertainty, marked by the shading from low to high emissions under each scenario.
- Warming refers to the expected global temperature rise by 2100, relative to pre-industrial temperatures.

Annual global greenhouse gas emissions
in gigatonnes of carbon dioxide-equivalents

150 Gt

100 Gt

50 Gt

Greenhouse gas emissions
up to the present

0

1990 2000 2010 2020 2030 2040 2050 2060 2070 2080 2090 2100

No climate policies

4.1 – 4.8 °C

→ expected emissions in a baseline scenario if countries had not implemented climate reduction policies.

Current policies

2.7 – 3.1 °C

→ emissions with current climate policies in place result in warming of 2.7 to 3.1°C by 2100.

Pledges & targets (2.4 °C)

→ emissions if all countries delivered on reduction pledges result in warming of 2.4°C by 2100.

2°C pathways

1.5°C pathways

Data source: Climate Action Tracker (based on national policies and pledges as of May 2021).
OurWorldinData.org - Research and data to make progress against the world's largest problems.

Last updated: July 2021.
Licensed under CC-BY by the authors Hannah Ritchie & Max Roser.

<https://ourworldindata.org/co2-and-other-greenhouse-gas-emissions>

26 OCT 2021 | PRESS RELEASE | CLIMATE ACTION

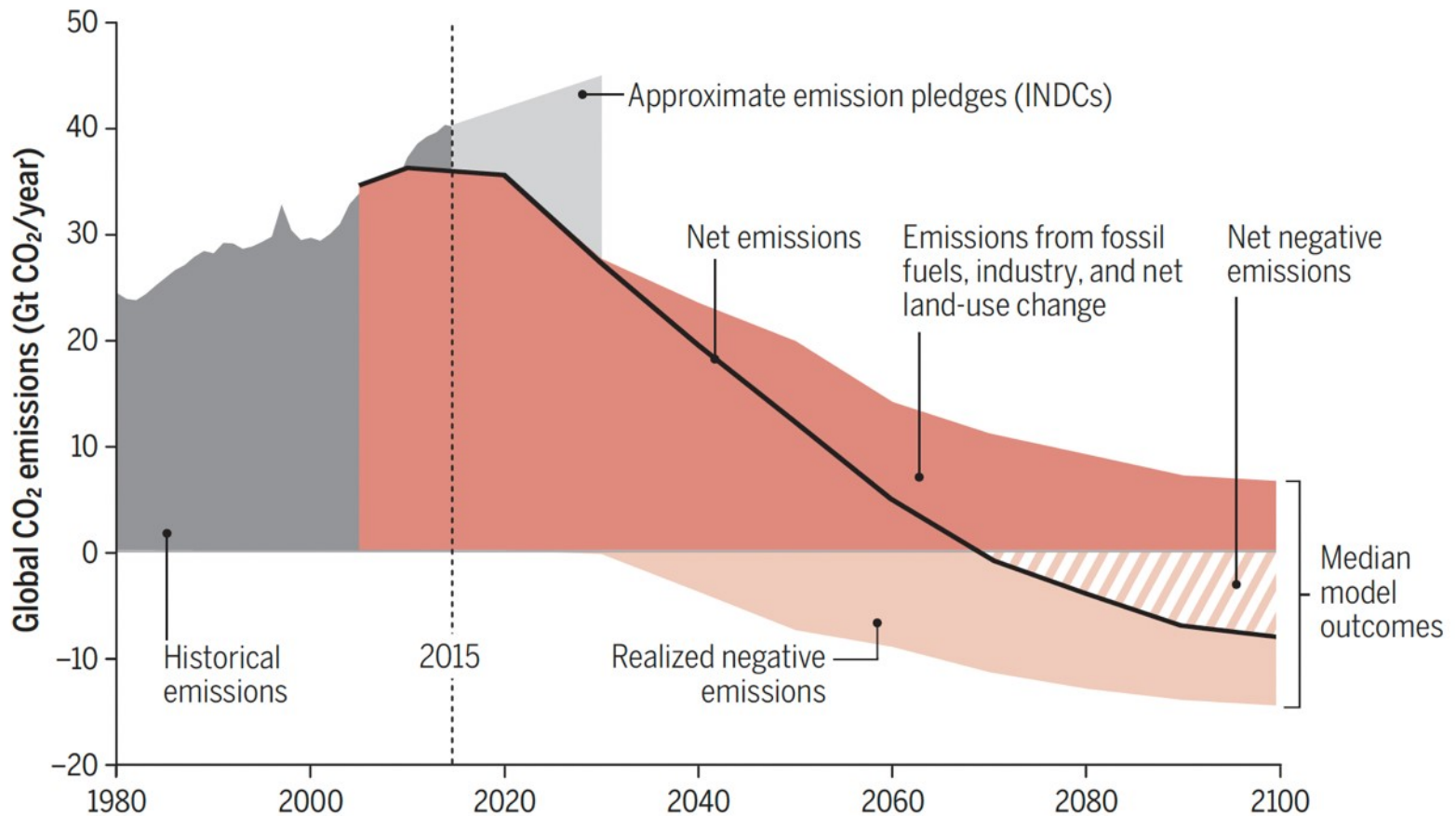
Updated climate commitments ahead of COP26 summit fall far short, but net-zero pledges provide hope

Pixabay / 26 Oct 2021

2021 UNEP Emissions Gap Report

- New and updated NDCs only reduce 2030 emissions by 7.5% when reduction of 55% is required to meet the 1.5°C Paris ambition.
- Current climate pledges for 2030 currently put the world on track for a warming of 2.7°C by the end of the century.
- Net zero pledges currently submitted for COP26 would only limit warming to 2.2°C.

<https://www.unep.org/emissions-gap-report-2020>



Reliance on future “negative emissions technologies” routinely used in models to limit the requirement to deliver immediate and rapid reductions in carbon emissions.

Anderson, K. & Peters, G., 2016. The trouble with negative emissions. *Science*, 354(6309), pp.182-183.



Let's reverse climate change

Together we can inspire 1 billion people to remove CO₂ from the air, with Climeworks direct air capture technology.

Remove CO₂



Act now



9'320 Pioneers

Enable **removal of CO₂** from the air



3_d 2_h 16_m

COP26 starts on 31st October: will we succeed in global climate action?

Join the journey towards a climate-positive world

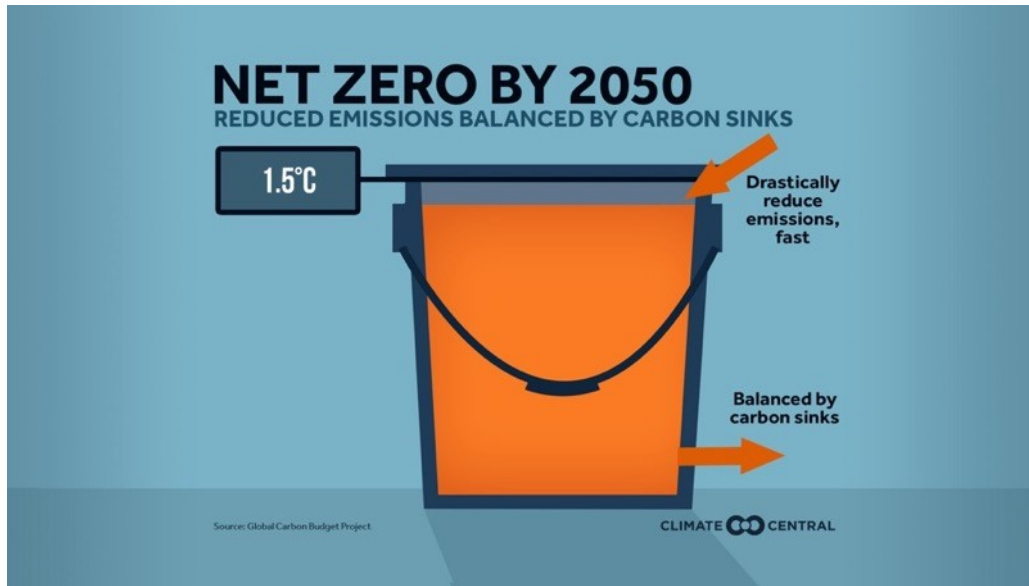
A climate-positive world requires us to reduce, reuse, recycle... then remove. We can remove unavoidable and historic CO₂ from the air in a safe and permanent way. Each and every one of us can make a huge impact and when we all do it together, we can change the world. #Actnow and stay up to date in our community.

<https://climeworks.com>

“The appropriateness or otherwise of relying, in significant part, on negative-emission technologies to realize the Paris commitments is an issue of risk. However, the distribution of this risk is highly inequitable.

If negative emission technologies fail to deliver at the scale enshrined in many integrated assessment models, their failure will be felt most by low-emitting communities that are geographically and financially vulnerable to a rapidly changing climate.”

Anderson, K. & Peters, G., 2016. The trouble with negative emissions. *Science*, 354(6309), p183.



Pollute now: Pay later?

“The time has come to voice our fears and be honest with wider society. Current net zero policies will not keep warming to within 1.5°C because they were never intended to. They were and still are driven by a need to protect business as usual, not the climate. If we want to keep people safe then large and sustained cuts to carbon emissions need to happen now. That is the very simple acid test that must be applied to all climate policies. The time for wishful thinking is over.”

The Conversation (22 April 2021): Climate scientists – concept of net zero is a dangerous trap (James Dyke, Robert Watson, Wolfgang Knorr)

<https://theconversation.com/climate-scientists-concept-of-net-zero-is-a-dangerous-trap-157368>

“Climate change is no longer a future problem. It is a now problem. To stand a chance of limiting global warming to 1.5°C, we have eight years to almost halve greenhouse gas emissions: eight years to make the plans, put in place the policies, implement them and ultimately deliver the cuts.

The clock is ticking loudly.”

Inger Anderson, Executive Director of UNEP

<https://www.unep.org/news-and-stories/press-release/updated-climate-commitments-ahead-cop26-summit-fall-far-short-net>

4. What can we do about it?

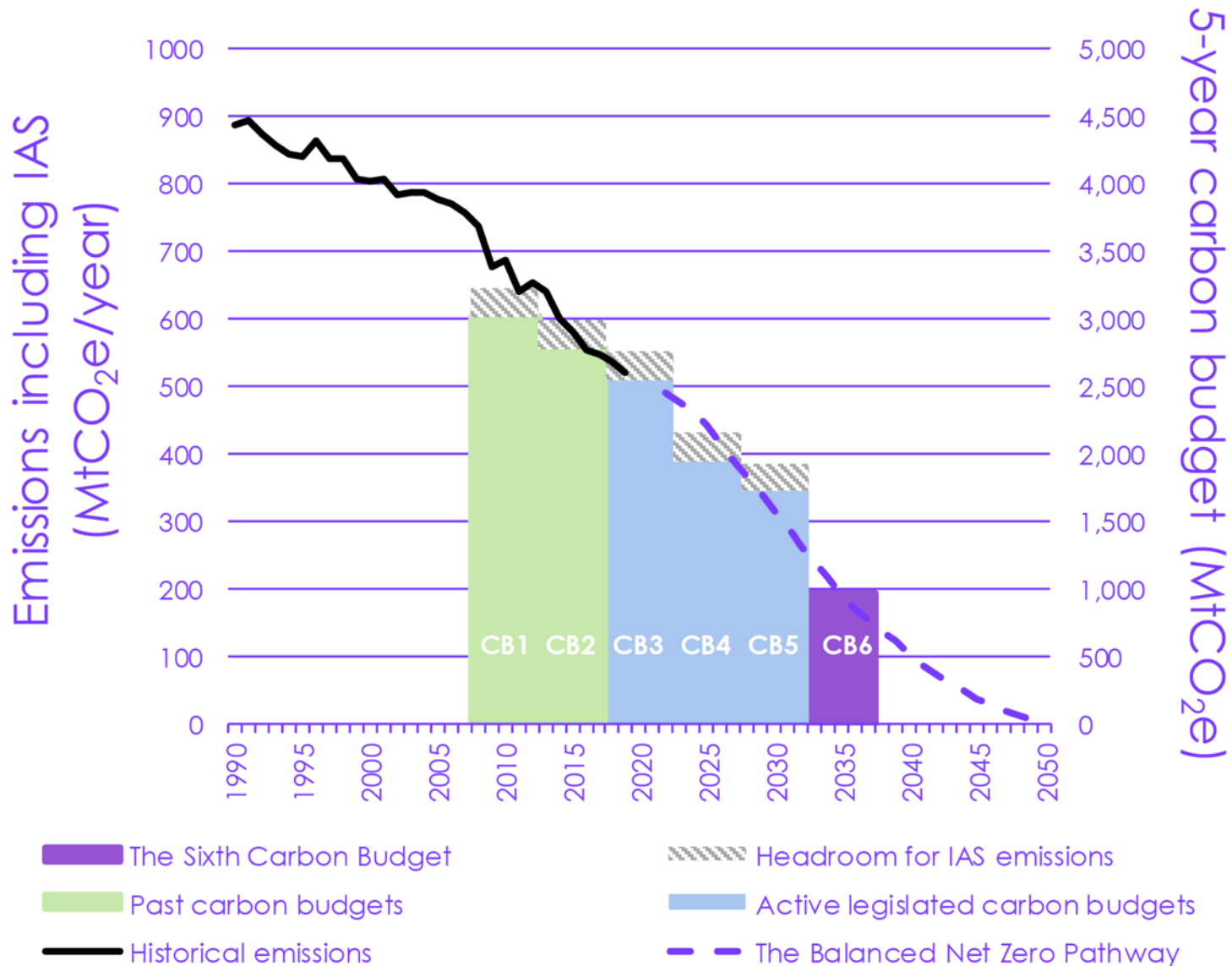
“Solving the climate crisis is the greatest and most complex challenge that *Homo sapiens* has ever faced. The main solution, however, is so simple that even a small child can understand it.

We have to stop our emissions of greenhouse gases.”

Greta Thunberg, 2019. *No one is too small to make a difference.* Penguin books. P21.

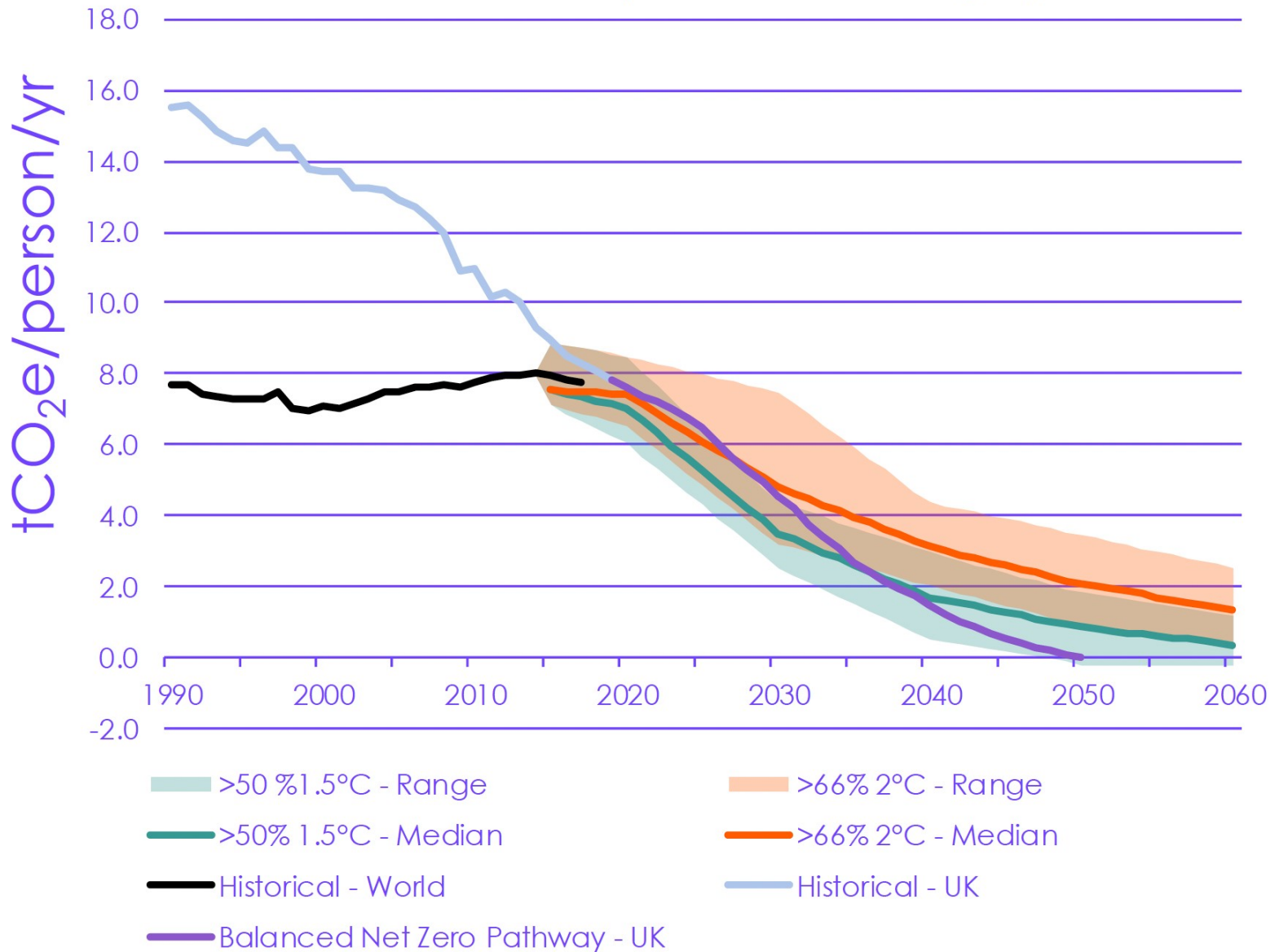
<https://www.wired.com/story/a-teen-started-a-global-climate-protest-what-are-you-doing/>



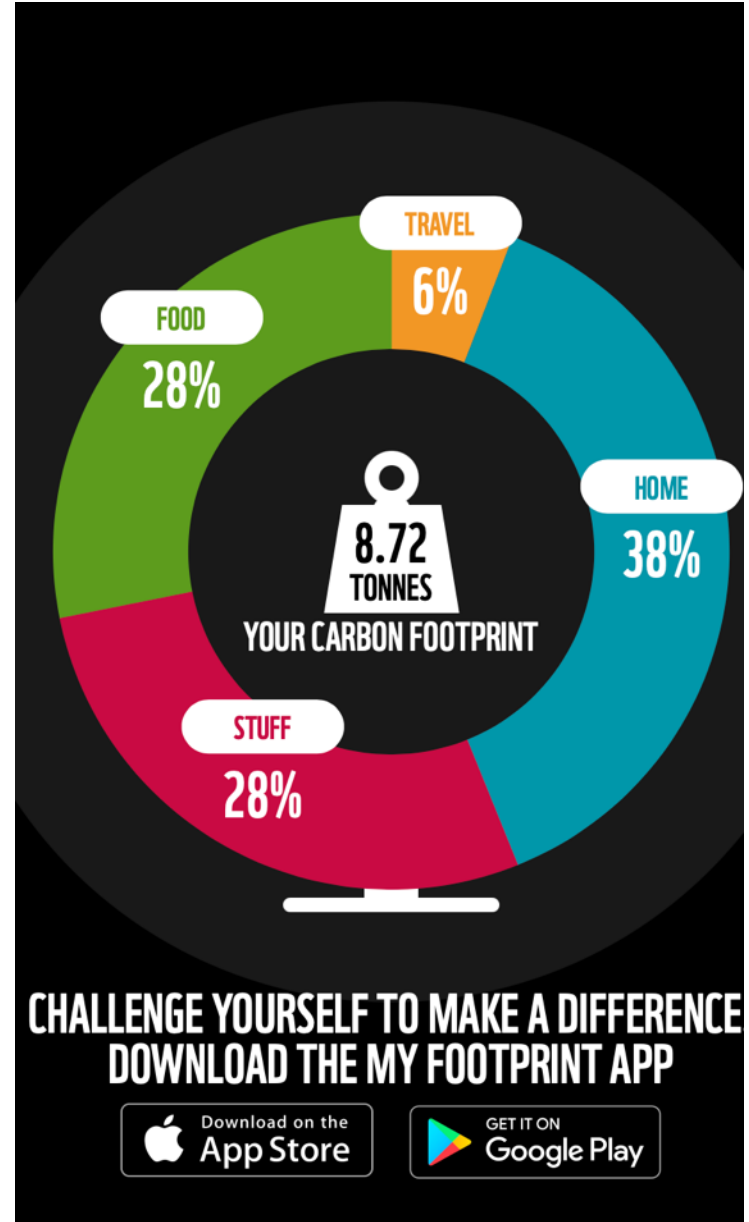
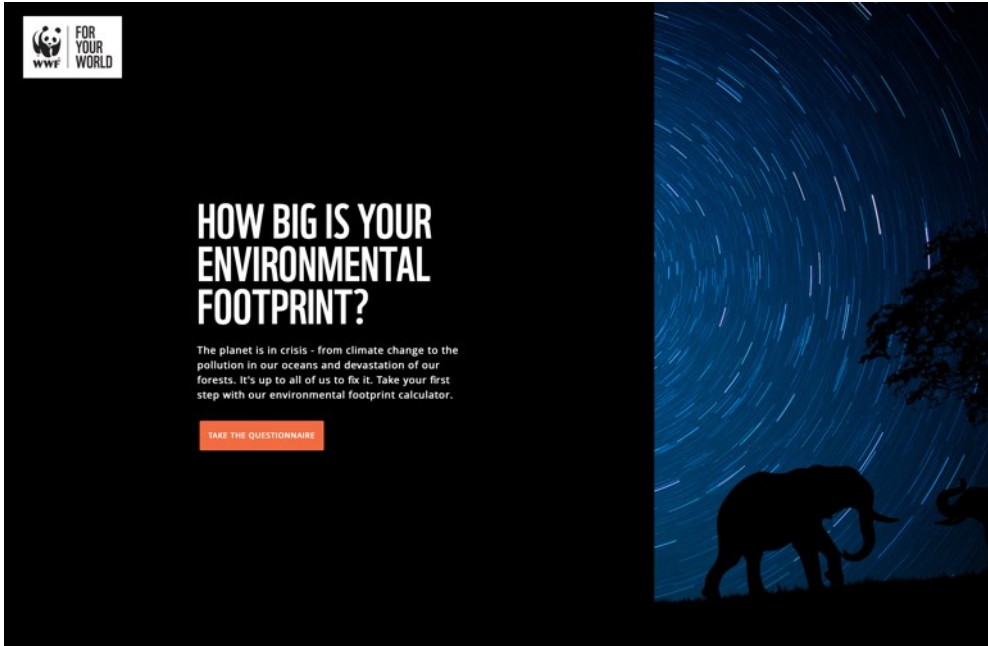


<https://www.theccc.org.uk/publication/sixth-carbon-budget/>

All GHG emissions (basis of the UK's targets)



<https://www.theccc.org.uk/publication/sixth-carbon-budget/>



Step 1: Take and active interest in your carbon footprint

World Wildlife Fund Carbon Footprint Calculator

<https://footprint.wwf.org.uk/>

Step 2: Reducing our footprint

1. Energy

how we power
our homes

2. Transport

how we
travel

3. Food

what we eat

Environmental Research Letters



TOPICAL REVIEW

OPEN ACCESS

Quantifying the potential for climate change mitigation of consumption options

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Keywords: sustainable consumption, carbon footprint, mitigation potential, food, transport, housing, climate change

Supplementary material for this article is available [online](#)

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Will include a series of figures from this paper that has attempted to quantify the potential carbon savings associated with a range of lifestyle and consumption options...

Available at: <https://iopscience.iop.org/article/10.1088/1748-9326/ab8589/meta>

CLIMATE CHANGE CAN I MAKE A DIFFERENCE?



Context

Climate change [Wikipedia](#)

Wikipedia

Climate change includes both human-induced global warming and its large-scale impacts on weather patterns. There have been previous periods of climate change, but the current changes are more rapid than any known events in Earth's history.



Can you really affect climate change? Yes. You can. Here's how...

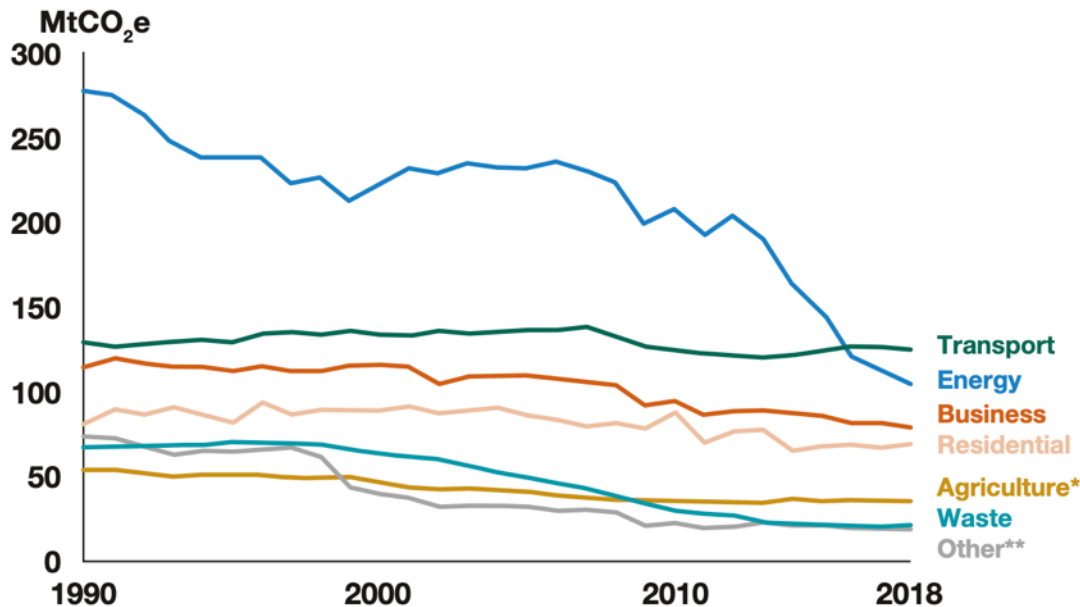
42,328 views • 28 Jul 2021

3.3K 144 SHARE SAVE ...

<https://www.youtube.com/watch?v=fRTic6mjCFk&t=310s>



1. Energy



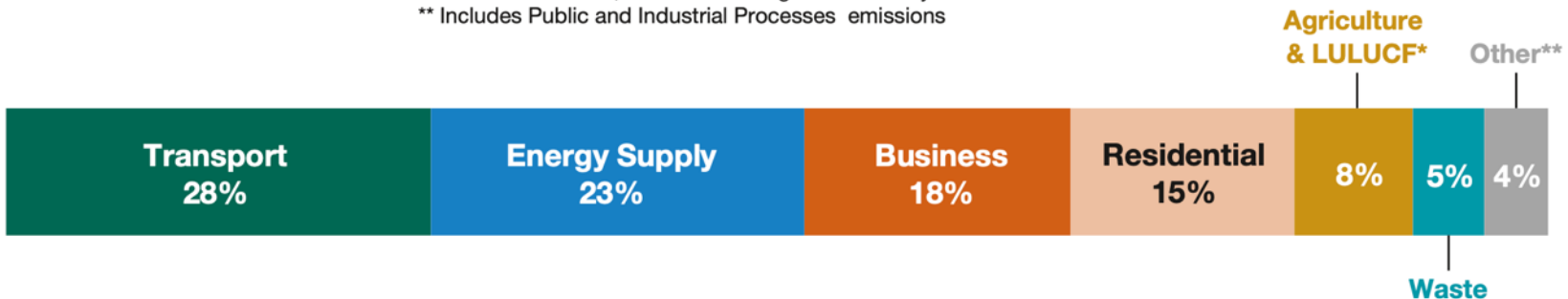
* Includes Land Use, Land Use Change and Forestry
 ** Includes Public and Industrial Processes emissions

Transport became the largest emitting sector of GHG emissions in 2016

This follows large decreases in energy emissions while transport emissions have remained relatively static.

451 million tonnes of CO₂ equivalent (MtCO₂e)

is the total net domestic greenhouse gas emissions from all UK sectors in 2018, down 2.1% from 2017.



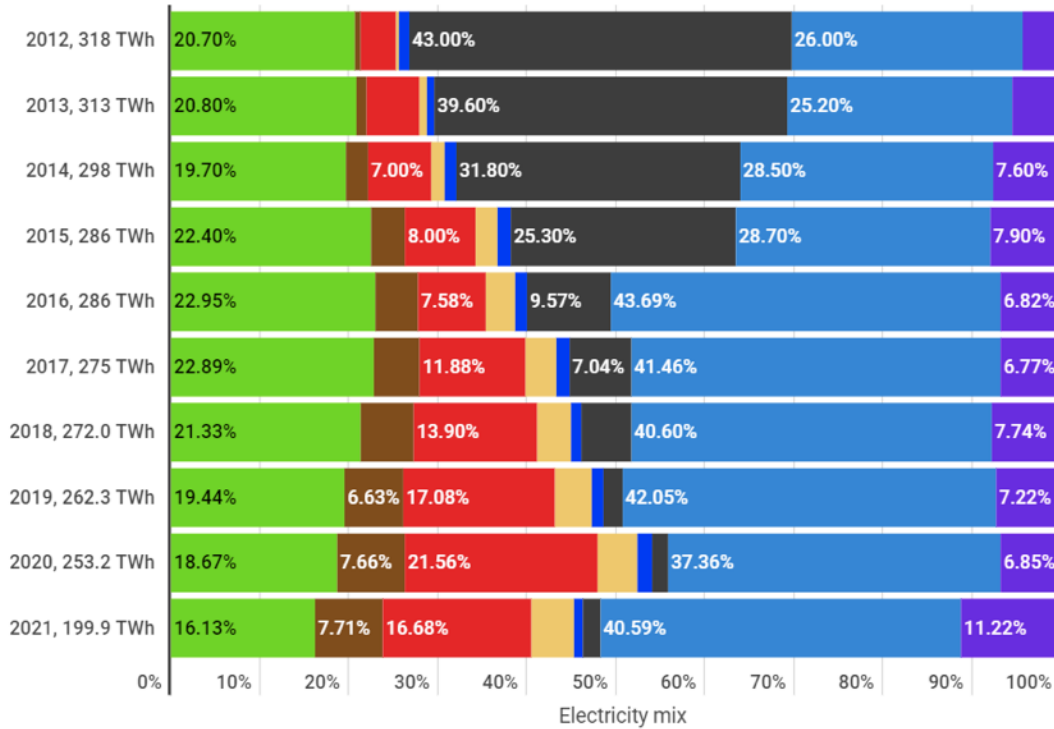
Source: 2018 UK greenhouse gas emissions¹⁰

DfT (2020) – Decarbonising Transport: Setting the Challenge (p11)

https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/932122/decarbonising-transport-setting-the-challenge.pdf

● Nuclear
 ● Biomass
 ● Wind
 ● Solar
 ● Large Hydro
 ● Coal
 ● Gas
 ● Imports

The same data can be viewed as the percentage of electricity from each source.



● Nuclear
 ● Biomass
 ● Wind
 ● Solar
 ● Large Hydro
 ● Coal
 ● Gas
 ● Imports

88.7

MT of carbon emissions in 2016

76.9

MT of carbon emissions in 2017

72.1

MT of carbon emissions in 2018

64.7

MT of carbon emissions in 2019

56.5

MT of carbon emissions in 2020

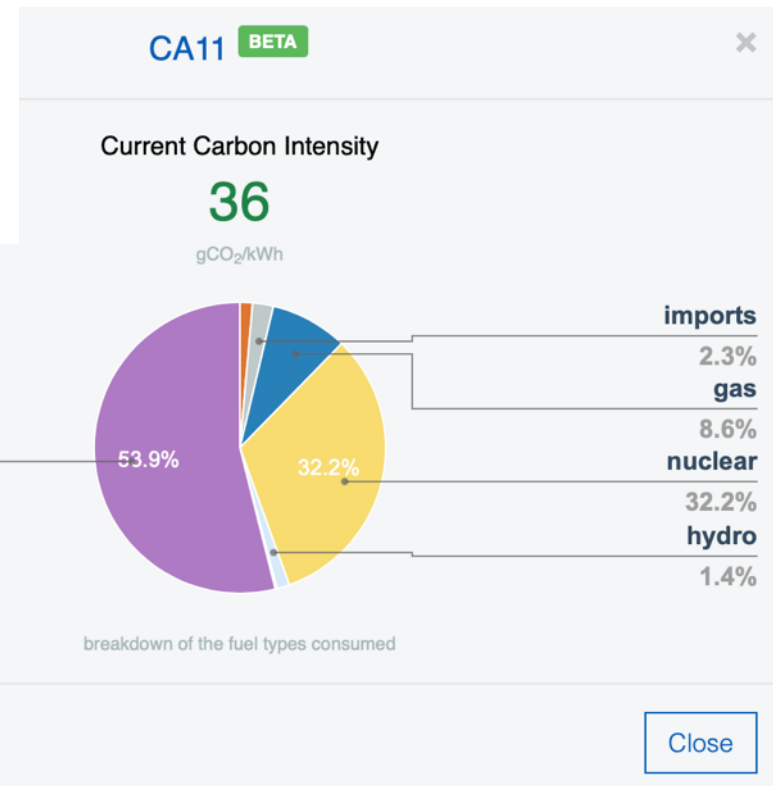
47.9

MT of carbon emissions in 2021

Substantial reduction in the carbon intensity of the UK national grid over the last decade. Principally due to a rapid reduction in the use of coal fired power stations.

Carbon intensity of the grid at 4pm on 27th October 2021

#	Region	Forecast Carbon Intensity (gCO ₂ /kWh)	Index
1	North Scotland	0	very low
2	South Scotland	13	very low
3	North East England	26	very low
4	North West England	36	very low
5	North Wales & Merseyside	95	low
6	East England	100	low
7	Yorkshire	111	low
8	West Midlands	113	low
9	South West England	138	low
10	London	160	moderate
11	East Midlands	174	moderate
12	South England	221	high
13	South East England	249	high
14	South Wales	313	high



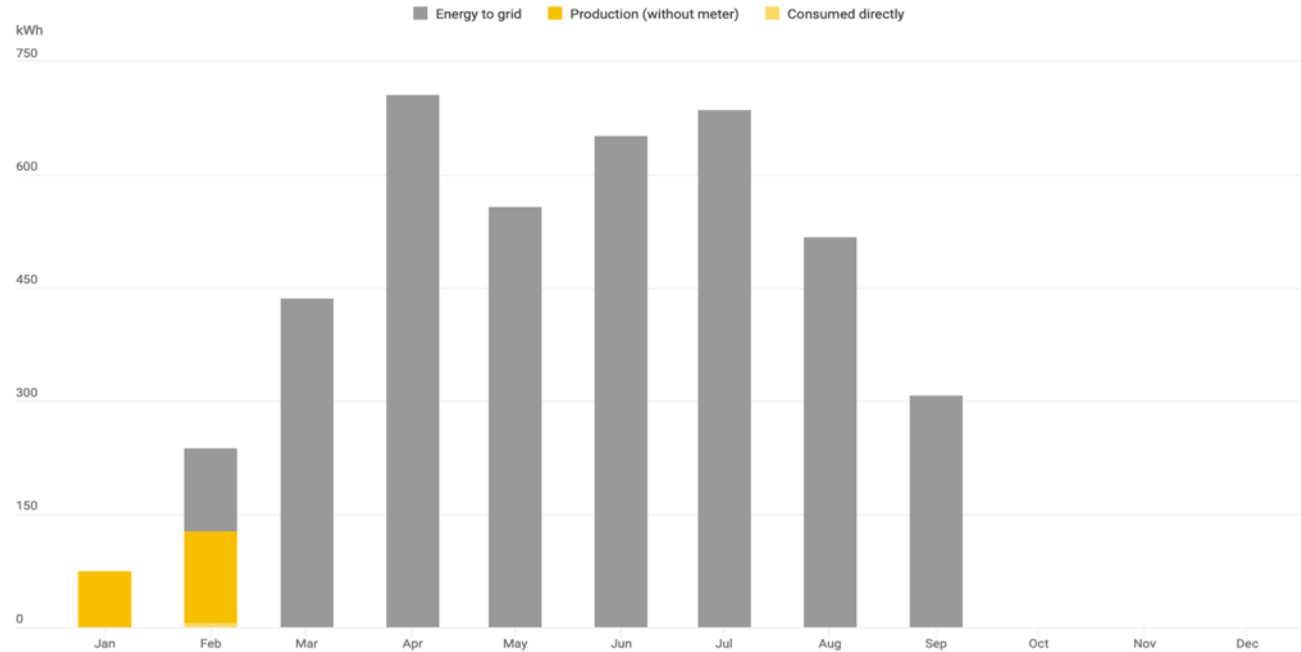
“Grow your own”

Solar PV generation

Totals to date:

Solar PV: 4185 kWh
 Home usage: 3281 kWh
 Import: 560 kWh
 Export: 1282 kWh

Equates to 757 kg of CO₂
 assuming grid carbon
 intensity of 181g CO₂/kWh



Month	Jan	Feb	March	April	May	June	July	Aug
Total	76	239	437	708	545	653	687	518
Average	4.5	8.5	14.1	23.6	17.6	21.8	22.2	16.7
Max	13.0	20.4	25.2	33.7	35.6	33.2	34.0	29.2
Min	0.3	1.2	2.0	8.2	4.1	6.3	7.3	6.9



Community Energy England

We are a membership body that supports organisations who want to see the community energy sector grow.

[Who we are >](#)



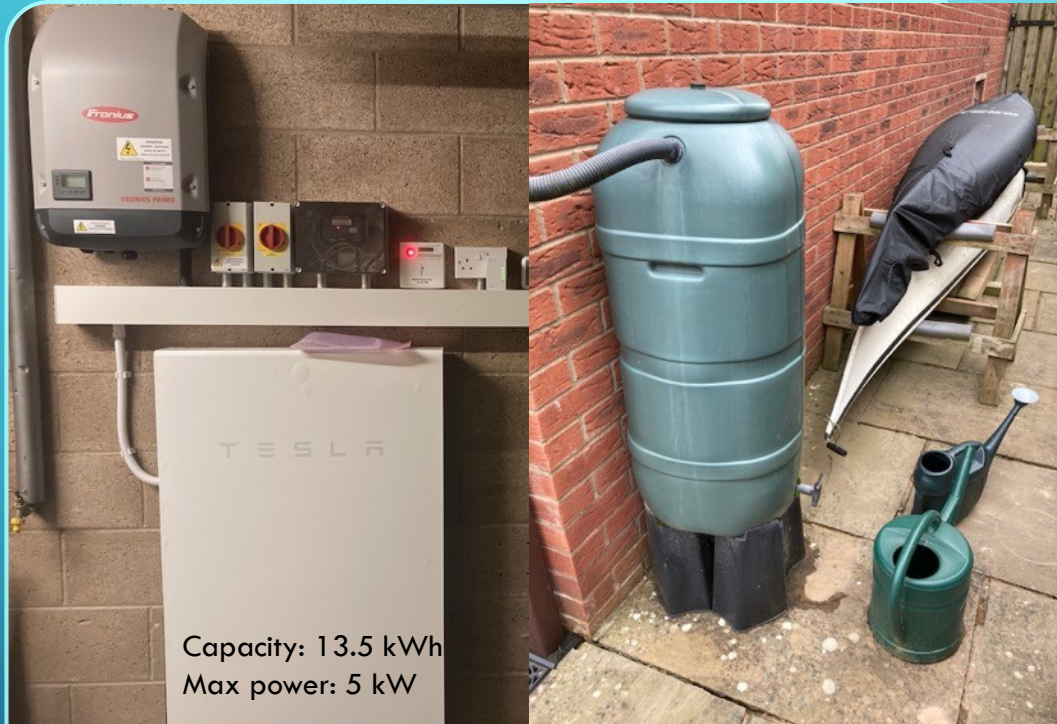
The Voice of the Community Energy Sector

We are a not-for-profit organisation dedicated to helping community energy organisations create and implement new projects by advocating for a policy landscape that will support community energy and providing opportunities for community energy practitioners to connect, learn, share business models and help each other overcome obstacles.

Something that can be done at the community scale via community energy projects and related social enterprise schemes.

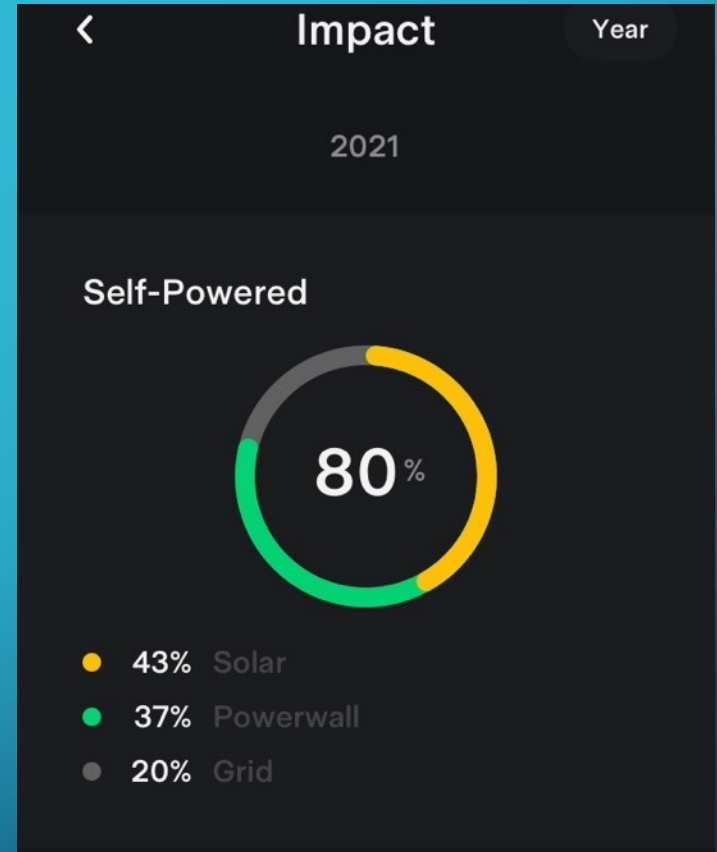
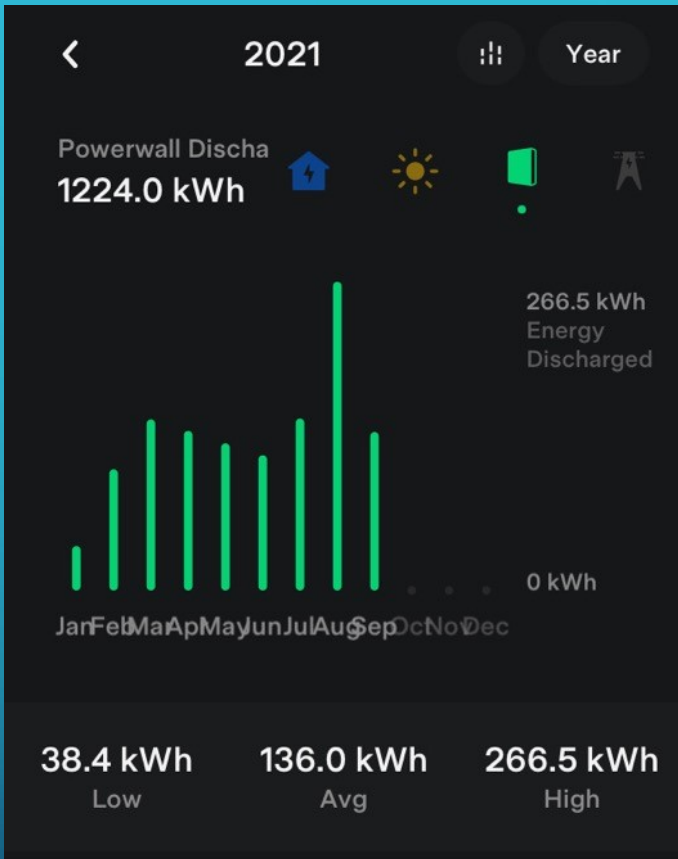
<https://communityenergyengland.org>

Domestic Energy Storage (Tesla Powerwall 2)



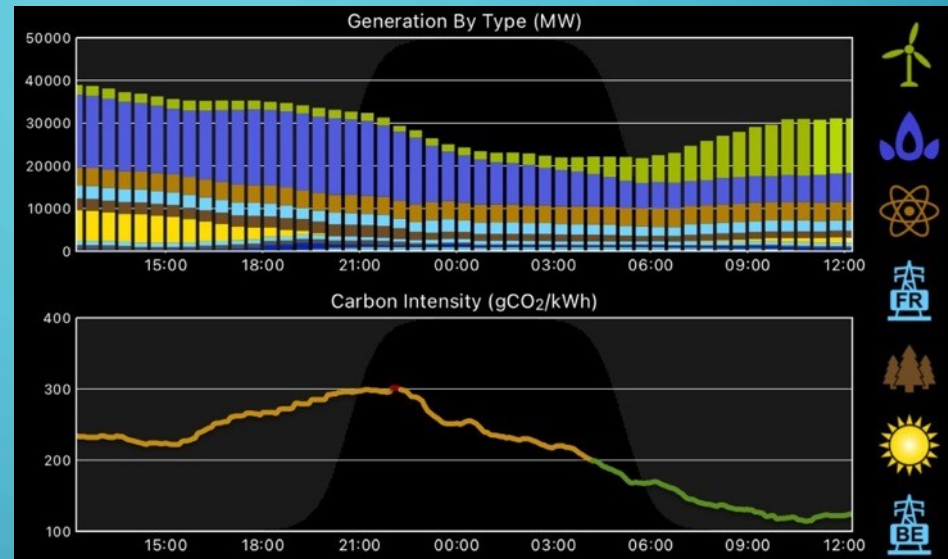
Domestic battery storage allows you to make much more use of your solar generation:

- Store surplus energy during the day to use overnight.
- To stay “off grid” during cloudy days.
- Greater self-sufficiency.



37% of the household consumption has come from the battery largely in the form of stored solar energy – allowed us to be 80% “self-powered” so far...

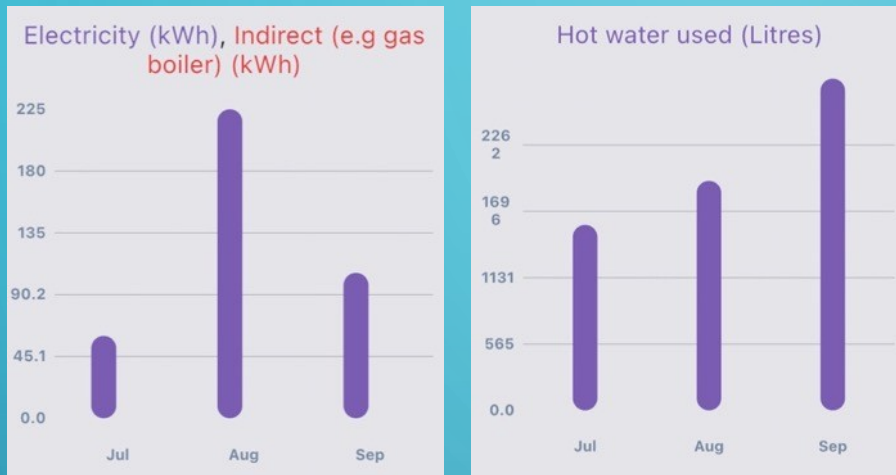
Taking advantage of “time of use tariffs”



Can use a domestic battery to take advantage of “time of use” tariffs:

- Charge during periods of low demand when energy is clean and cheap.
- Use stored energy to avoid grid use when energy is expensive and more carbon intensive.

Mixergy Hotwater tank



Installed 23rd July

- Planned use to reduce use of gas to produce hot water.
- Can heat water using surplus solar energy.
- Can also make use of time of use tariffs.
- Compatible with heat pumps.



Heating



1 in 20 homes with a gas boiler could join a heat network, saving **2 tonnes of CO₂** per year.



1 in 4 homes currently using oil heating, and **1 in 3 homes** using electric heating could switch to a heat pump, saving **3.2 tonnes of CO₂ per year** and **0.8 tonnes of CO₂ per year** respectively.

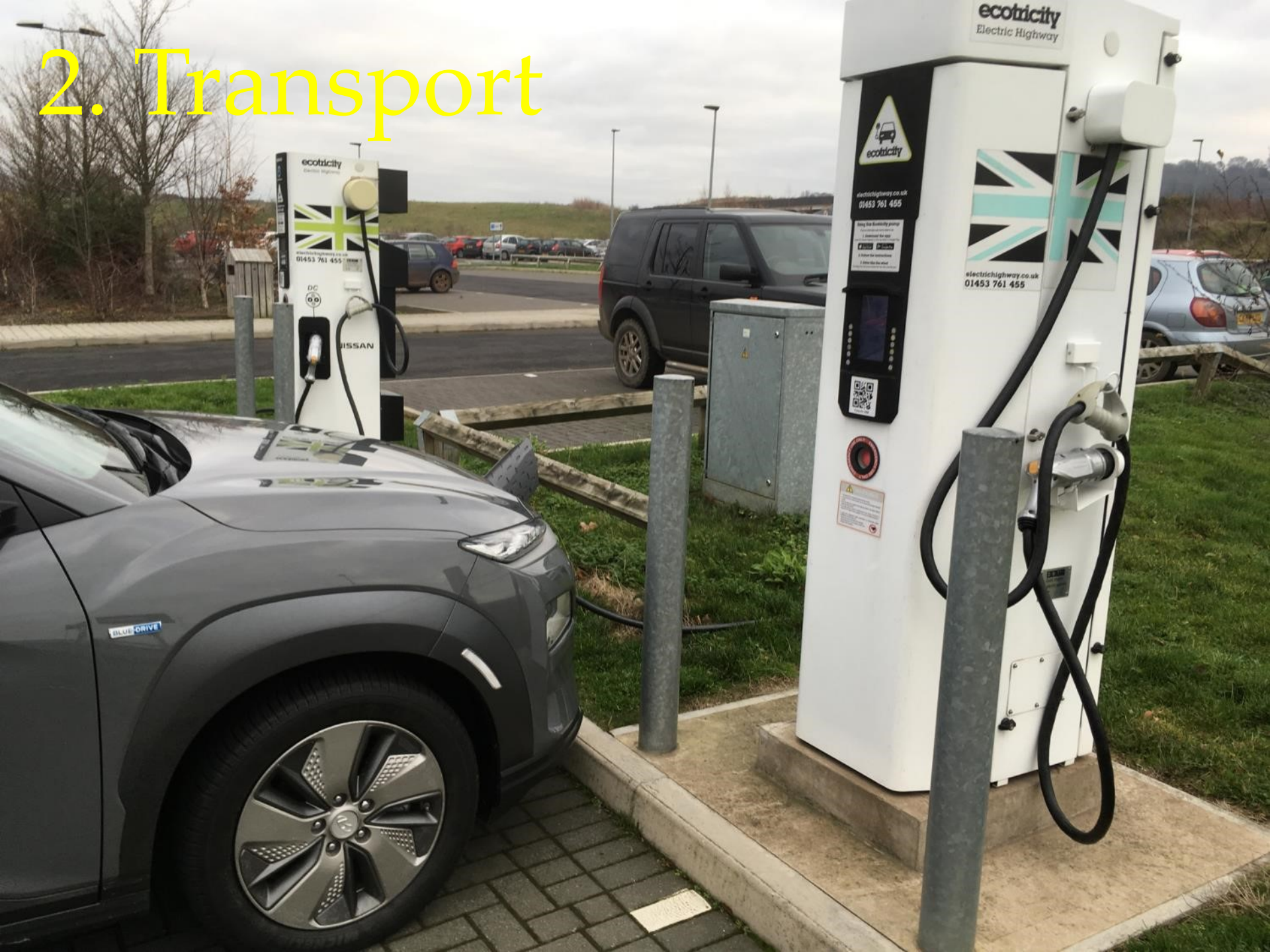
Housing



Quick wins

- Switch to LED light bulbs
- Use smart meter to monitor your energy use.
- Turn down your thermostat.
- Fit an aerated shower head.
- Enhance household insulation.
- Replace “white goods” with energy efficient options when they fail.

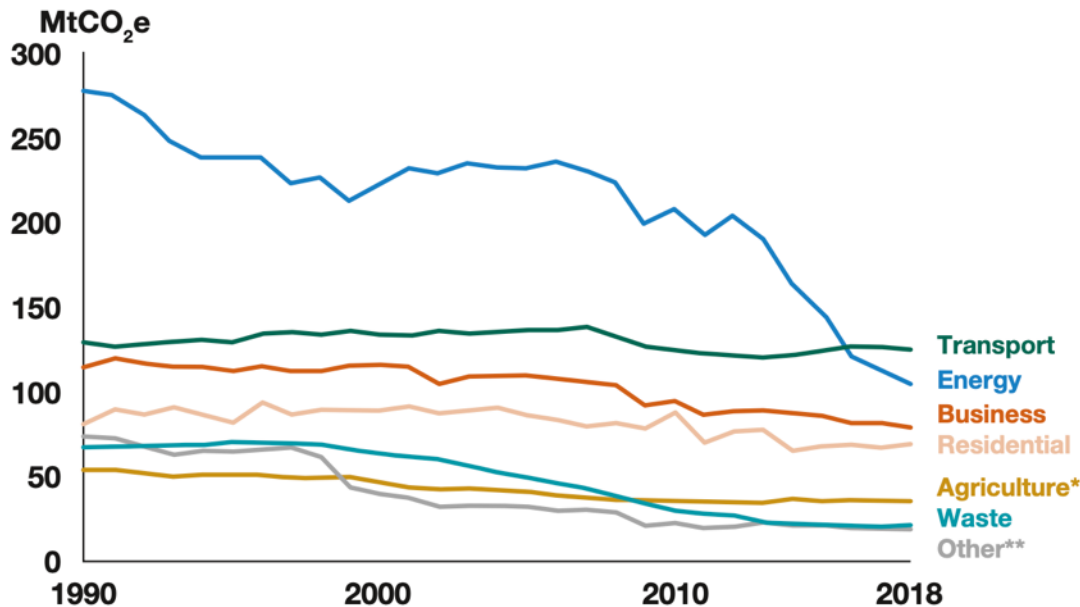
2. Transport



Transport & Carbon

- Transport sector is responsible for the release of 8 Gt/yr of CO₂ emissions (25% of global total).
- 74% of these emissions relate to road transport.
- Est. 1.2 billion cars in operation.
- Additional 100 million produced annually.
- Global transport sector emissions **increased** by 71% between 1990-2016.

Holmatov, R. & Hoekstra, A.Y., 2020. The environmental footprint of transport by car using renewable energy. *Earth's Future*, 8, e2019EF001428.



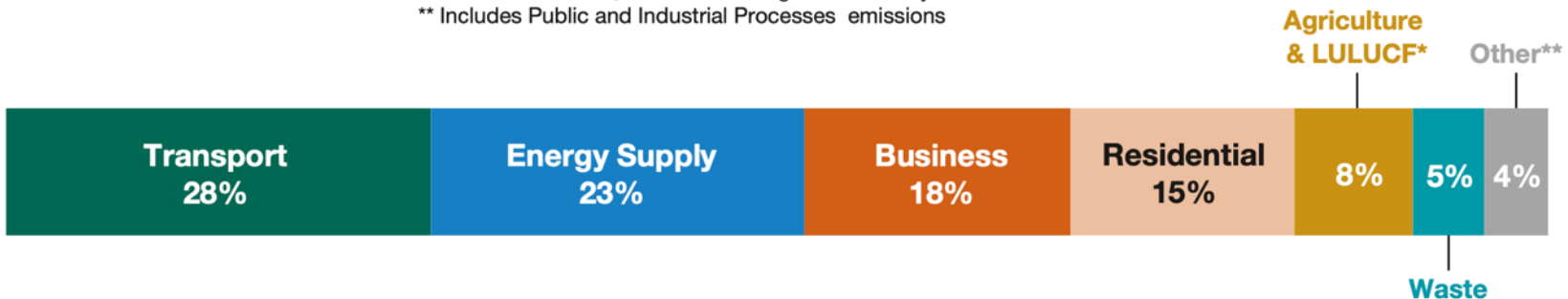
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Transport became the largest emitting sector of GHG emissions in 2016

This follows large decreases in energy emissions while transport emissions have remained relatively static.

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is the total net domestic greenhouse gas emissions from all UK sectors in 2018, down 2.1% from 2017.



Source: 2018 UK greenhouse gas emissions¹⁰

DfT (2020) – Decarbonising Transport: Setting the Challenge (p11)

https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/932122/decarbonising-transport-setting-the-challenge.pdf

Carbon footprint of travel

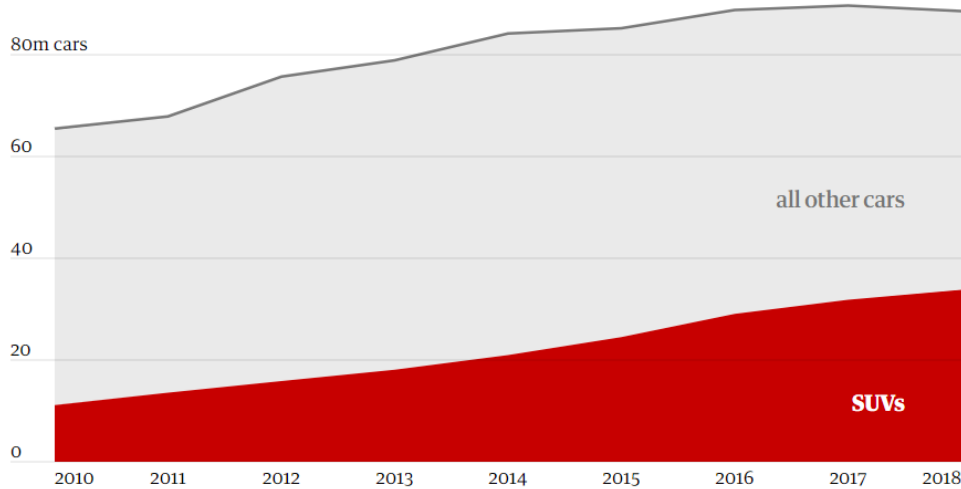
London to Glasgow (return) – 411 miles

- 30kg CO₂e bike
- 40kg CO₂e coach
- 64kg CO₂e train
- 148kg CO₂e small BEV (driver only)
- 237kg CO₂e small efficient ICE car (driver only)
- 368kg CO₂e plane
- 1002kg CO₂e large SUV (driver only)

Berners-Lee, M., 2020. *How bad are bananas?* Profile Books. P114-116.
Based around full life cycle. See the book for details on the assumptions employed.

SUV sales are growing despite overall stagnation in the car market

Global passenger car sales



Source: IEA

Car manufacturers driving demand in the wrong direction in the promotion of SUVs ("Sports Utility Vehicles")?



<https://pxhere.com/en/photo/999350>

"If SUV drivers were a nation, they would rank seventh in the world for carbon emissions."

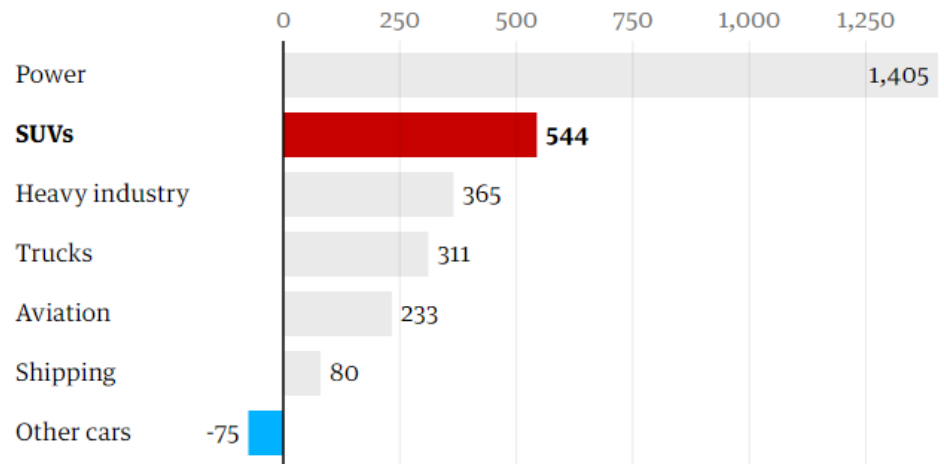
Increase in SUV ownership has been the second biggest cause of increased carbon emissions in the 21st Century...

Guardian Online 25th October 2019

<https://www.theguardian.com/environment/ng-interactive/2019/oct/25/suvs-second-biggest-cause-of-emissions-rise-figures-reveal>

SUVs were the second largest contributor to the increase in global carbon emissions from 2010 to 2018

Change in global emissions by sector (in MtCO₂)



Source: IEA

How can we reduce the carbon emissions of transport?

- Encourage walking and cycling.
- Greater use of public transport.
- More efficient engines.
- Use of low carbon fuels.
- Electrification of drivetrains coupled with an increase in the use of renewables...

13 CLIMATE
ACTION



Co-benefits – cost savings

“Back of the envelope calculation” based around an annual mileage of 20,000 miles...

Petrol car (Skoda Fabia)

Average economy of 45mpg
=2020 litres of fuel

Petrol cost of £1.26/litre

Total cost = £2545.20

EV (Hyundai Kona)

Average efficiency of 3.6mi/kWh
=5556 kWh

Charging split between home
and work (Keele)

Home = $2778 \times 0.165 = £471$

Work = $2778 \times 0 = £0$

Total cost = £458.37

Servicing and maintenance costs are also generally much cheaper.

+ Zero road tax.

EV Smart Charging – MyEnergi Zappi



CHARGE LOG		Σ00152
First:	31/15/27	
Last:	21/09/21	
Grid:	347.35kWh	31%
Green:	809.68kWh	69%
Total:	1157.03kWh	
Time :	048d 21h42m28s	

- Accelerating shift to battery electric vehicles – key change is the potential to “refuel” your car at home.
- Smart chargers allow you do divert surplus solar energy to your car to provide low carbon travel.

To date: 810 kWh diverted to the car = **3240 miles @ 4mi/kWh**

Table 1

Carbon, Land and Water Footprint per km and per Capita Year⁻¹ of Driving a Car Fuelled by Conventional Gasoline, Biodiesel Blend B20, Bio-Ethanol Blend E85, Bio-Electricity, Solar Electricity or Solar-Based Hydrogen

	Gasoline	Biofuel blend		Electricity	Hydrogen	
		B20 ^{1,a}	E85 ^{2,a}	Bio ^{3,a}	Solar (PV) ^c	
Carbon footprint (g CO ₂ eq/km)	165	185 ^b	80.2 ^b	7.3 ^b	0	0
Land footprint (m ² /km)	0	0.37	0.21	0.028	0.00091	0.0023
Water footprint (L/km)	0.25	170	163	40	0.12	0.39
Carbon footprint (kg CO ₂ eq/driver/year)	3579	4010	1739	158	0	0
Land footprint (m ² /driver/year)	0	7977	4463	611	20	50
Water footprint (m ³ /driver/year)	5	3685	3534	859	3	8

Notes: ¹ 20% biodiesel from rapeseed and 80% conventional diesel; ² 85% bioethanol from sugar beet and 15% conventional gasoline; ³ from sugarcane's biomass;

^a assuming circular production (using bioenergy to produce bioenergy);

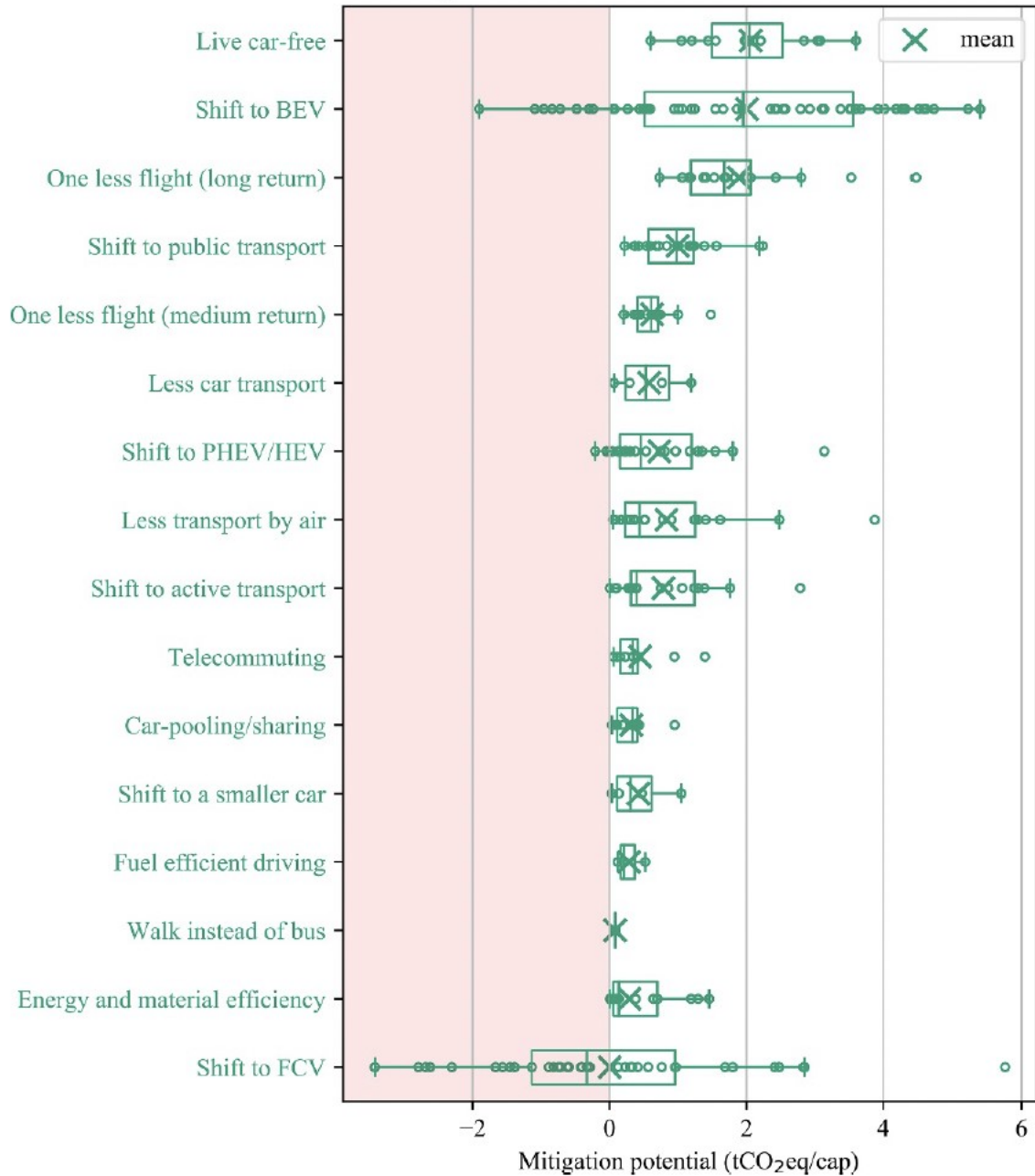
^b the CF of biofuels originates from nitrogen fertilizer production and soil management while the CF of bioelectricity also includes nitrous oxide and methane emissions during combustion;

^c assuming circular production (using solar PV panels to make solar PV panels). Fuel efficiencies refer to: 2019 Kia Forte FE or 2019 Toyota Camry for conventional gasoline; 2019 Chevrolet Cruze Hatchback for B20; 2016 Mercedes-Benz E350 for E85; 2019 Honda Clarity EV or 2019 Nissan Leaf (40kWh battery pack) for electric; and 2019 Honda Clarity for hydrogen. We assume here the average annual travel distance as in the US (FHWA, 2018), which is 21687 km.

"From the environmental footprint perspective, solar-powered battery-electric vehicles are the most resource efficient per unit of distance"

Holmatov, R. & Hoekstra, A.Y., 2020. The environmental footprint of transport by car using renewable energy. *Earth's Future*, 8, e2019EF001428.

Transport

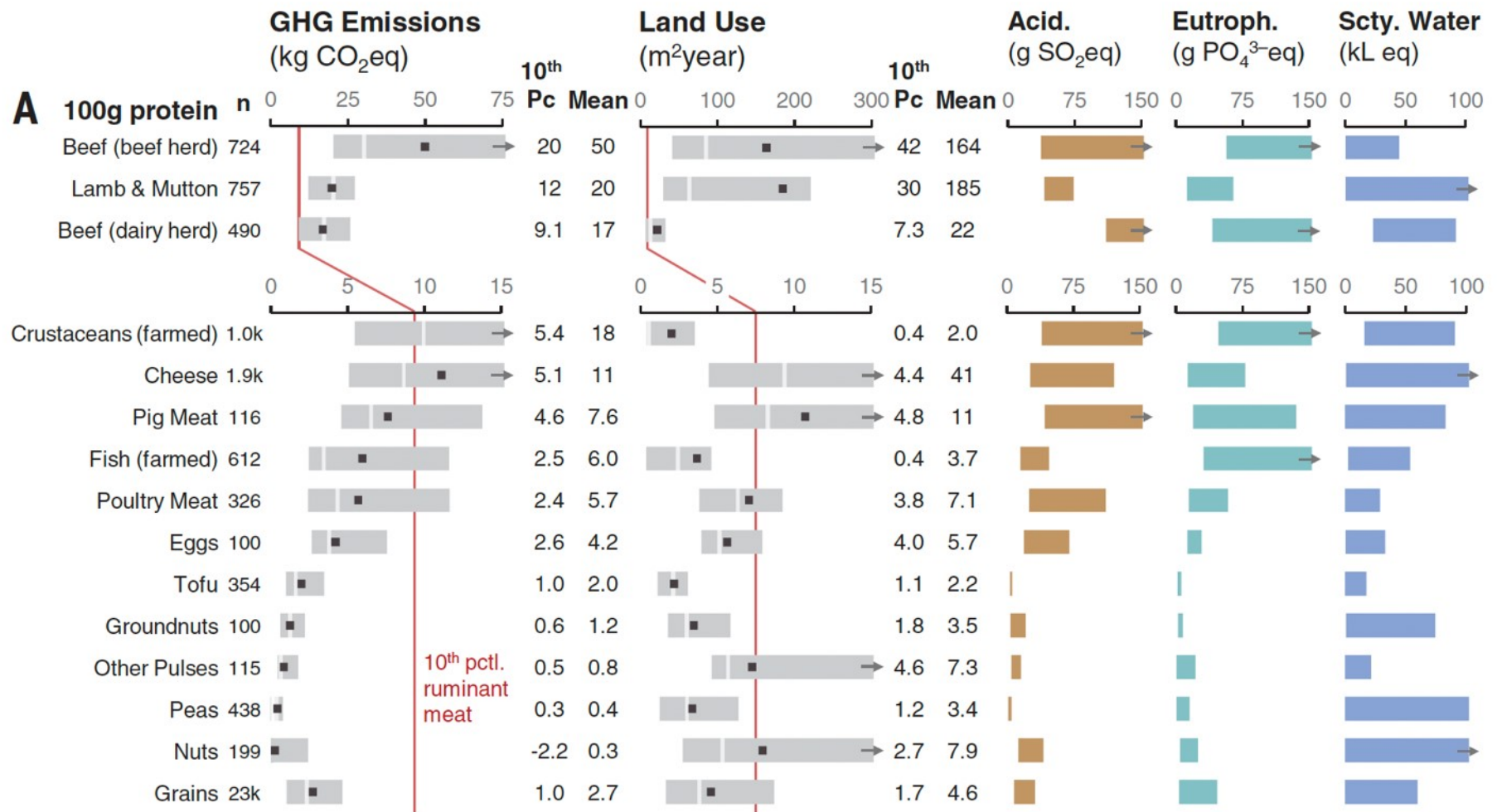


Quick wins

- Rely more on active travel for short journeys.
- Use public transport when possible.
- Think twice about flying.
- Opportunity to hold meetings online?

3. Food

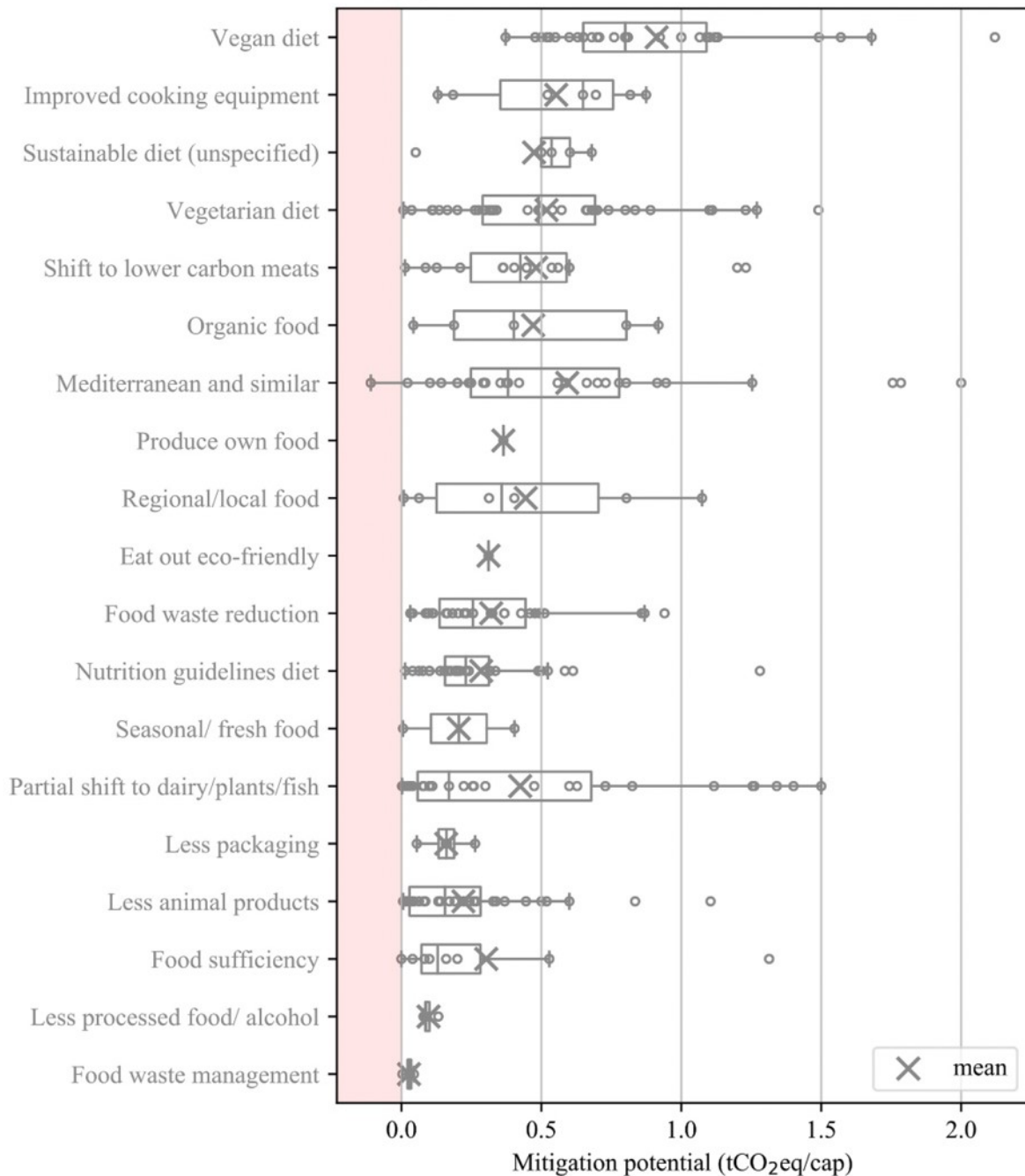




Environmental footprints of protein-based foods.

Poore, J. & Nemecek, T., 2018. Reducing food's environmental impacts through producers and consumers. *Science*, 360(6392), pp.987-992.

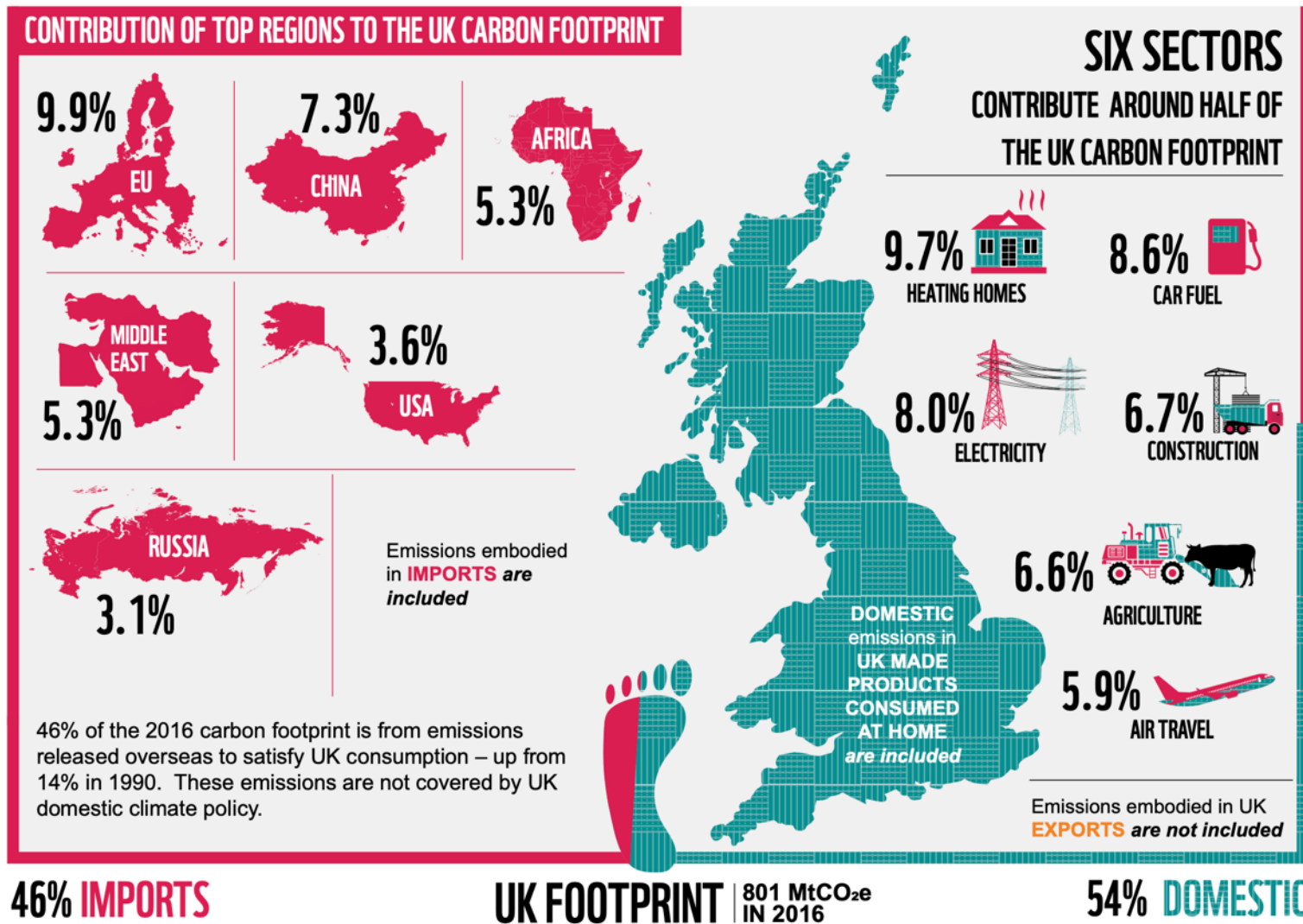
Food



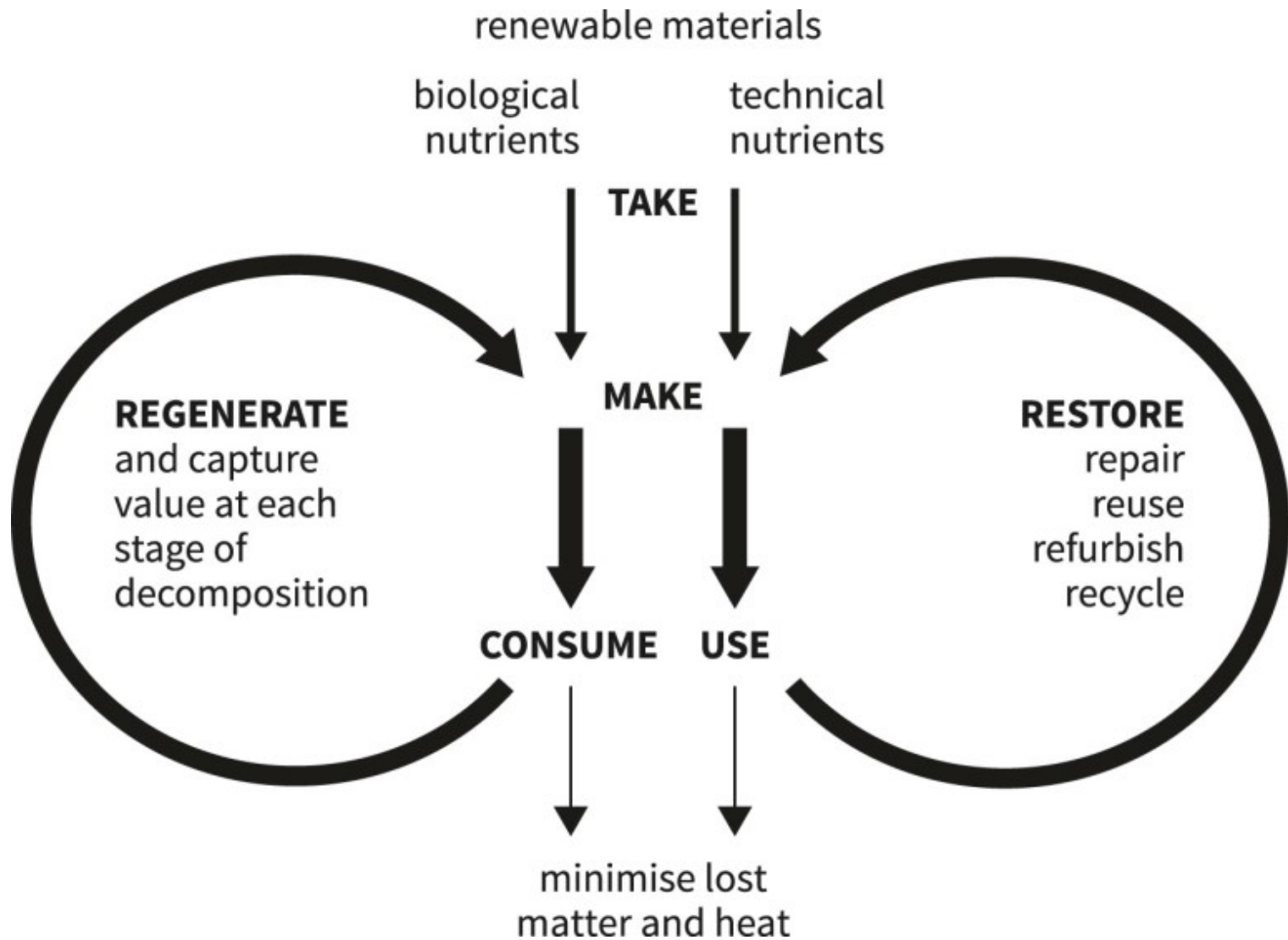
Quick wins

- Limit food waste
- Reduce red meat consumption.
- Eat more plant-based meals.
- Eat seasonal food where possible.
- Grow your own food.
- Low carbon cooking options.

...and finally...



[https://www.wwf.org.uk/sites/default/files/2020-04/FINAL-WWF-UK Carbon Footprint Analysis Report March 2020%20%28003%29.pdf](https://www.wwf.org.uk/sites/default/files/2020-04/FINAL-WWF-UK%20Carbon%20Footprint%20Analysis%20Report%20March%202020%28003%29.pdf)



5. Envisioning a positive future



“Bringing about the world we want to live in, the world we want to leave our children is, substantially, the work of the imagination.”

Hopkins, R., 2019. *From What Is to What If*. Chelsea Green. P7.



Artistic depiction of a future low carbon city produced by James McKay.

<https://www.robhopkins.net/2019/01/07/james-mckay-the-man-who-draws-the-future/>

"Future must enter into you a long time before it happens..."
Rob Hopkins

"In a moment we are going to take a journey through time.

This is a historic moment, the first time in [insert name of your community] that an act of collective time travel has been attempted. I have with me here my Time Machine that I built during lockdown from bits I had in at home and using plans I found online. When I turn it on, we are going to travel forwards to 2030. The times we travel through, were the times of the most profound and remarkable transition in human history.

Change that in 2020 felt unimaginable built and built in positive and accelerating cascades. Institutions that felt so permanent in 2020 crumbled and fell, and new, infinitely better ones bloomed in their place. Those 10 years were the most thrilling time to be alive. They are times that those that came afterwards told great stories about and sang great songs about. I am turning this Time Machine on and we are travelling forwards together.

Let's step out, emerging blinking into this new world. It's not a Utopia, but it is the result of everything that could possibly have been done being done. Take a walk around it in your imagination using all your senses."



Thanks for listening...!



Any questions?

The logo features the text "Eden Wild Goose" in a bold, white, sans-serif font, centered within a square frame. The frame consists of a dark red outer border and a lighter red inner border. Between these borders is a complex, interlocking knotwork pattern in a dark red color. The text is stacked vertically: "Eden" on the top line, "Wild" on the middle line, and "Goose" on the bottom line.

**Eden
Wild
Goose**