Welcome this evening


Eden
Wild
Goose
Community Choir

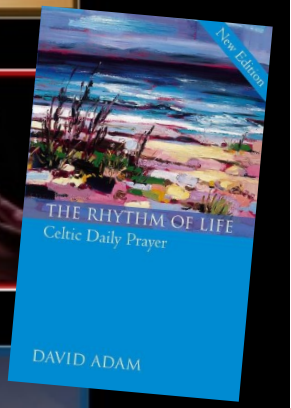

Eden
Wild
Goose
Art


Eden
Wild
Goose
Nature


Eden
Breakfast


Eden
Wild
Goose
Storytelling


Eden
Wild
Goose
Pray


New Edition
THE RHYTHM OF LIFE
Celtic Daily Prayer
DAVID ADAM


Crafty Gaggle
Craft Group
Eden
Wild
Goose


EWG Good Book Club
Eden
Wild
Goose
MESSIAH
IMMERSE
The Bible Reading Experience


Posada
Journey
to Bethlehem
Eden
Wild
Goose


Eden
Wild
Goose
Nature
CACAO
Curiosity
Appreciation
Celebration
Action
Opportunity

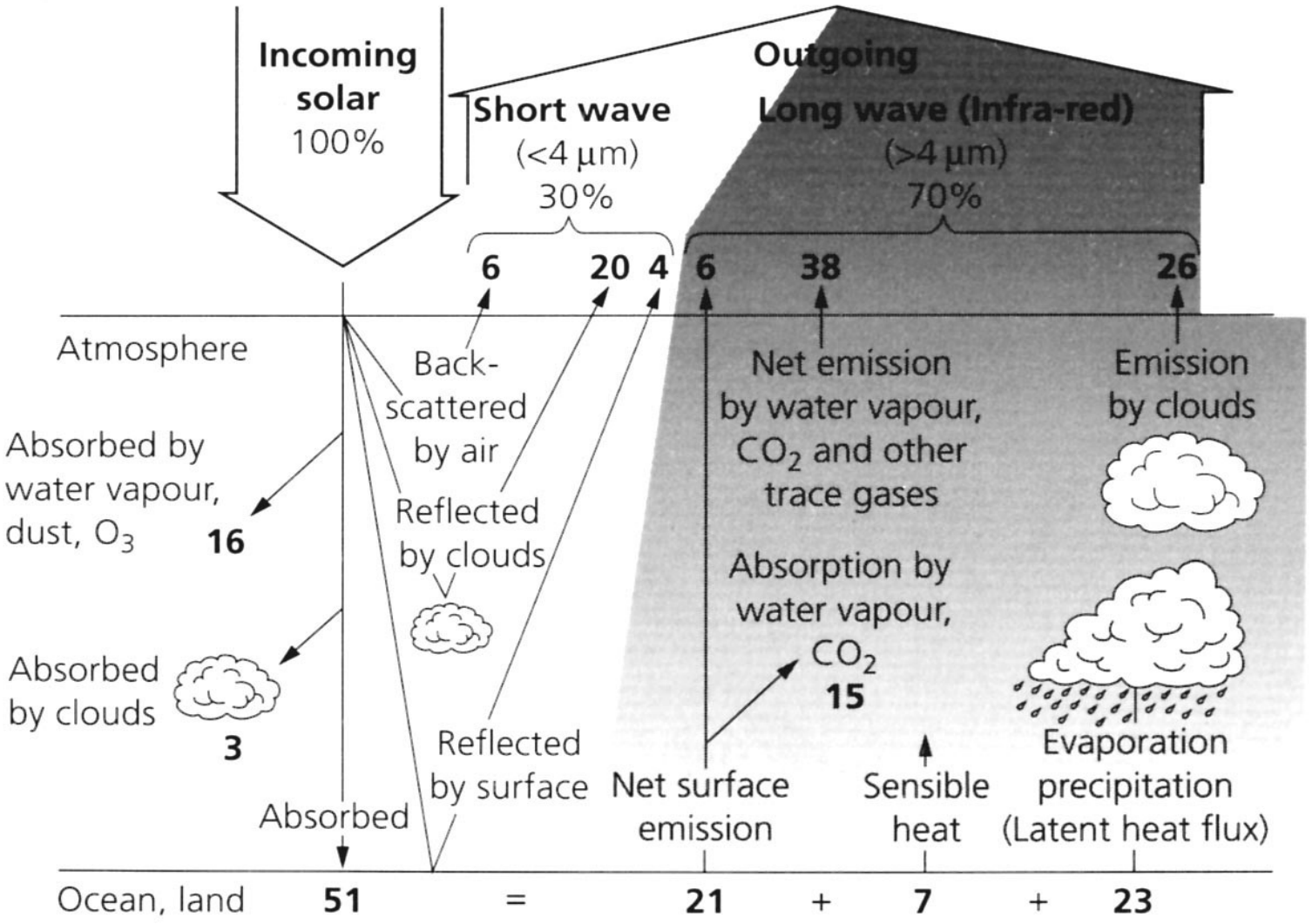
The Climate is Changing:
but what on Earth can I do about it?

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

Talk Outline

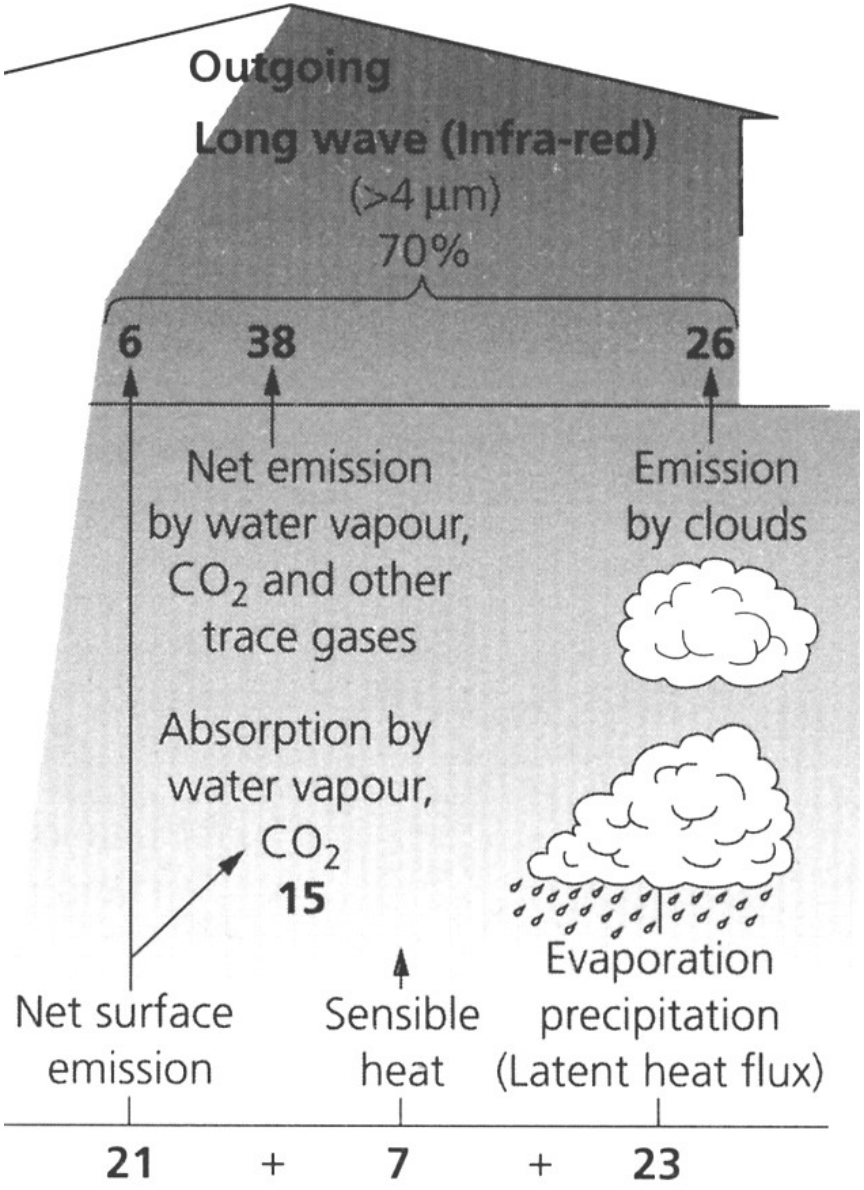
1. **Climate Change: the core science**
2. **The Environmental Impacts**
3. **Carbon Budgets and COP 26**
4. **What can we do as individuals and communities?**
5. **Envisioning a positive future**

1. Climate Change: the core science



(Allen, 1997)

Terrestrial Radiation

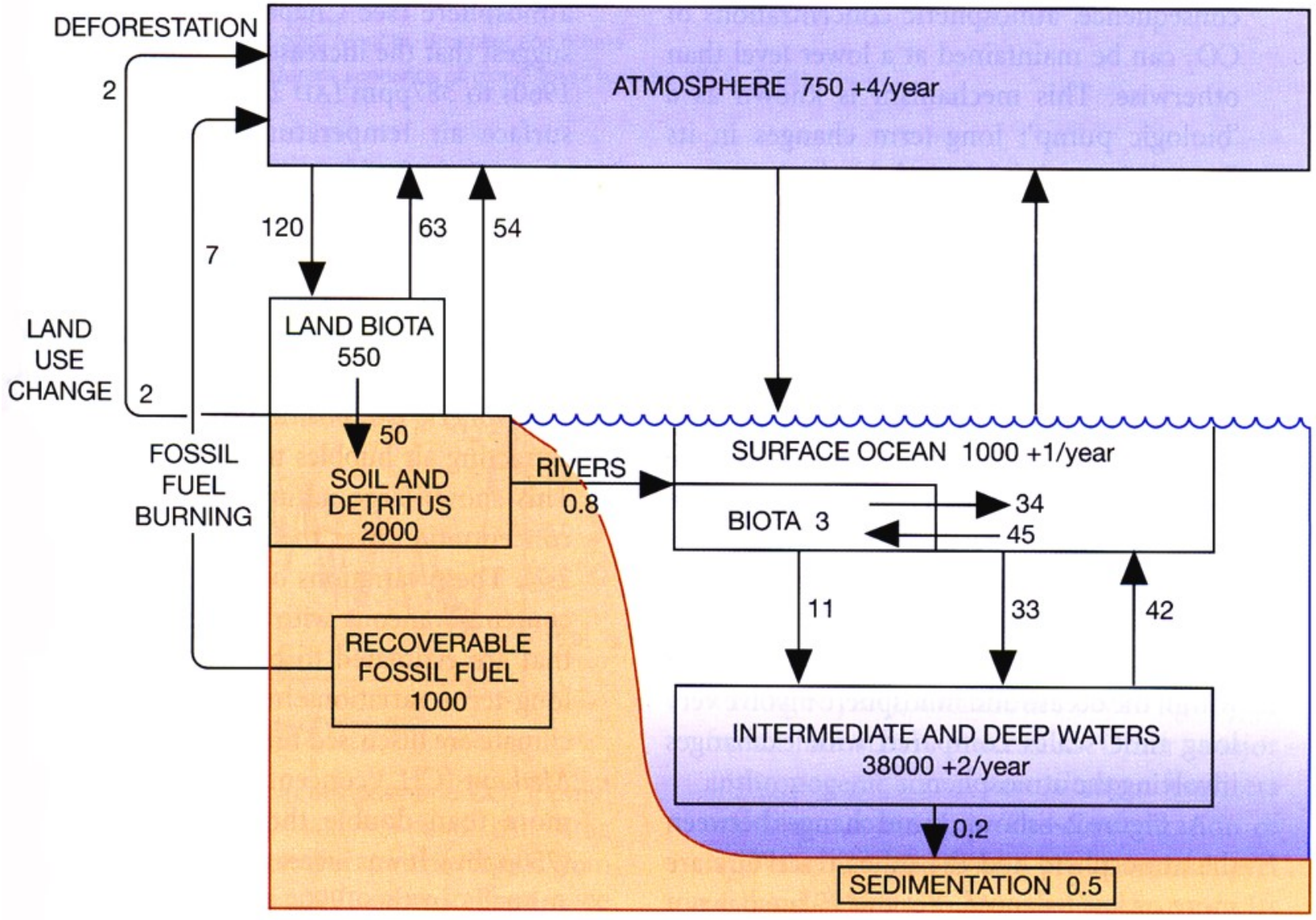


”Greenhouse effect” relates to the absorption of outgoing long-wave radiation from the Earth.

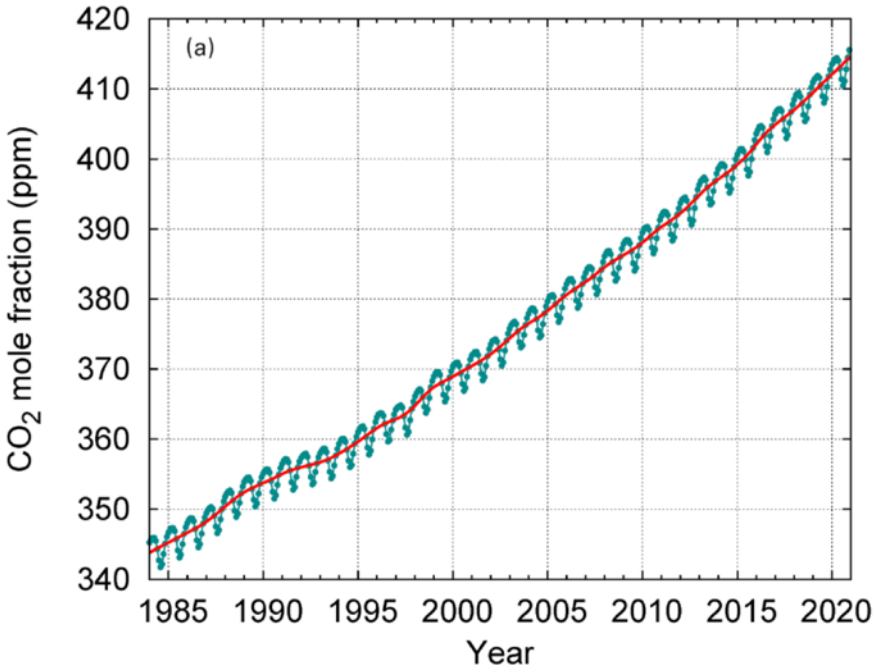
71% of outgoing long-wave radiation is absorbed contributing to atmospheric warming.

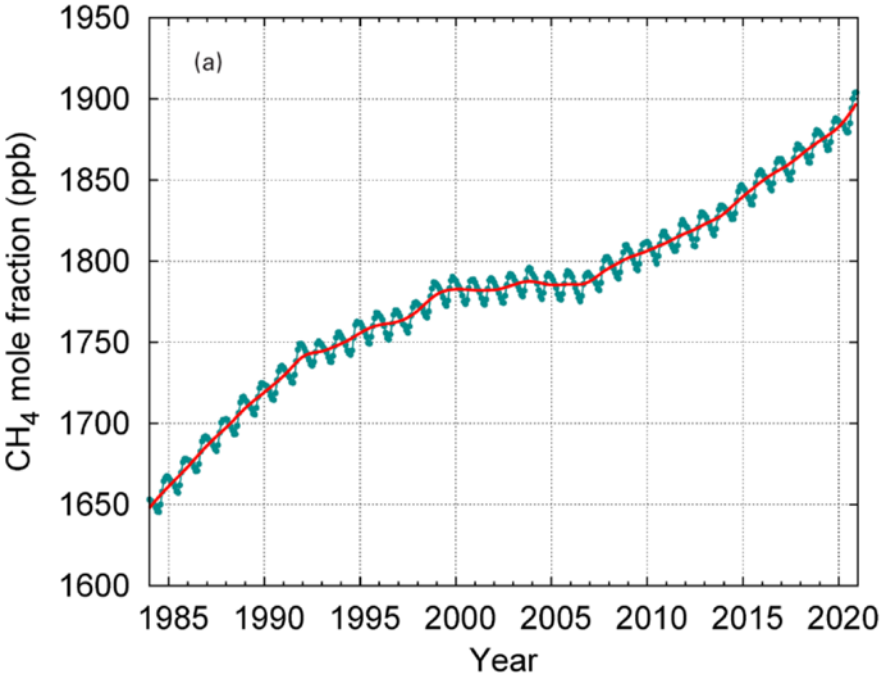
Net warming contribution of 33°C

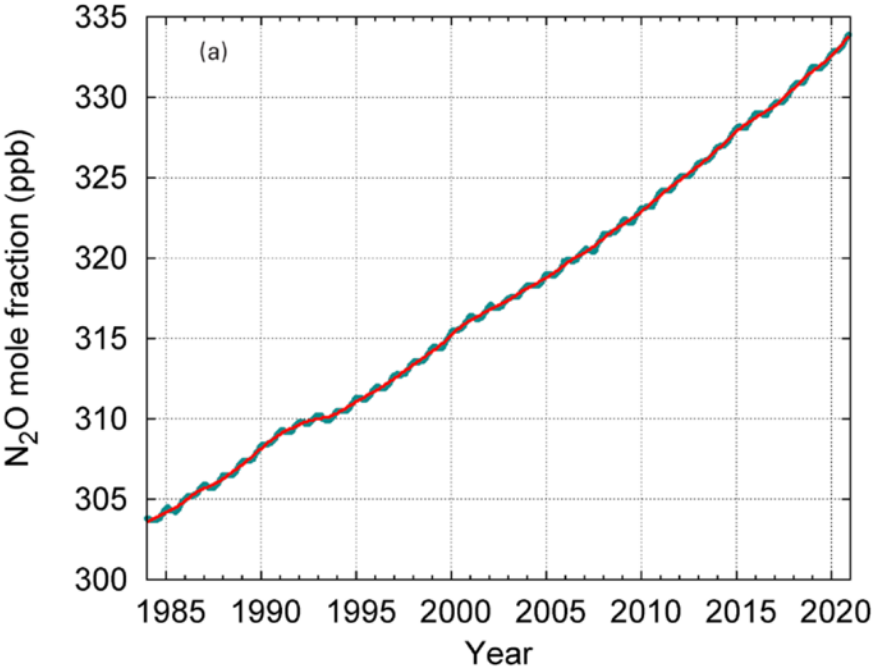
- 21°C due to water vapour.
- 7°C due to carbon dioxide.
- 2°C due to ozone.
- 3°C due to other trace gases.



Global carbon reservoirs (GtC) and gross annual fluxes ($GtC.yr^{-1}$)
(Barry & Chorley, 2010, p23)



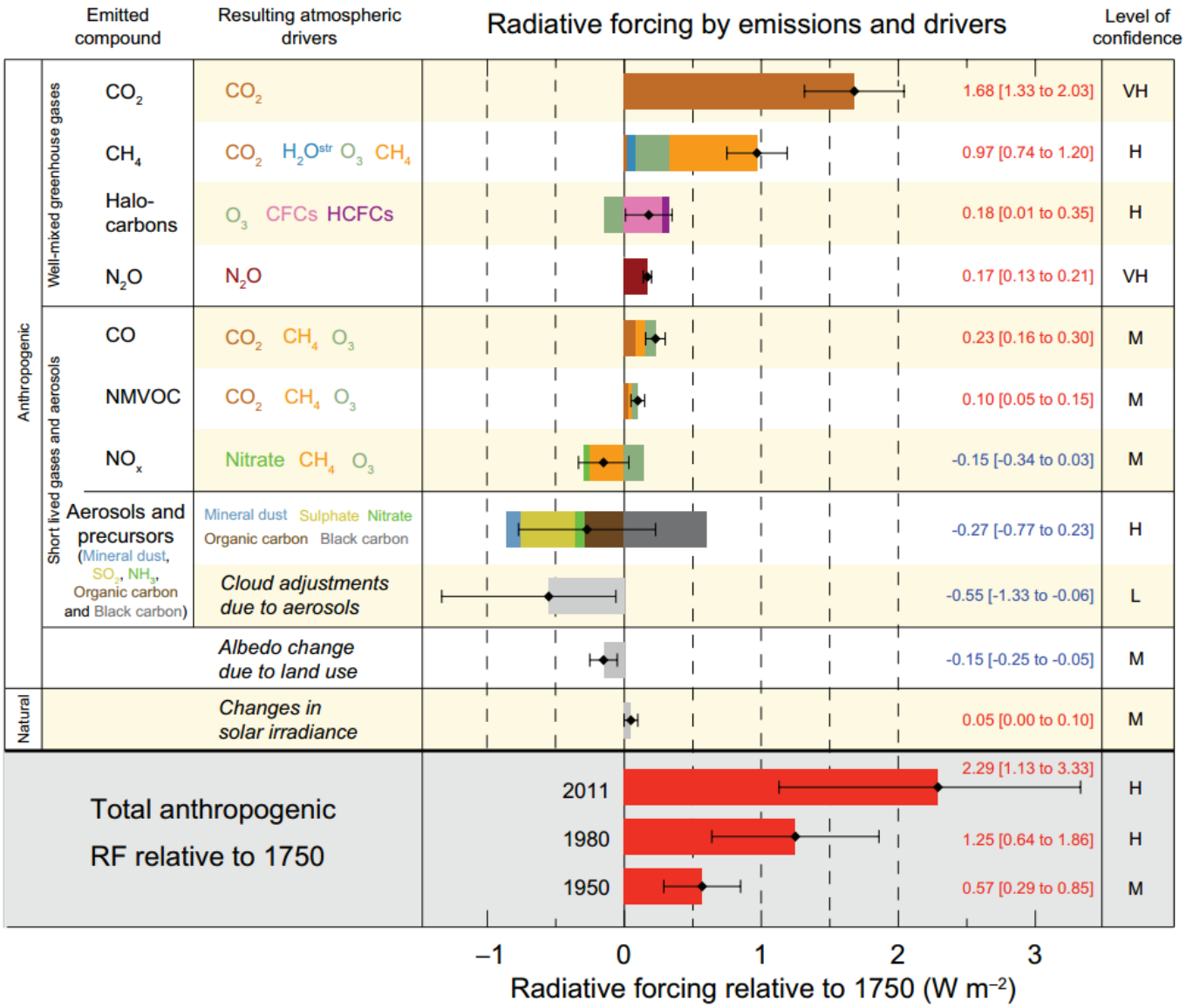




Recent changes in the atmospheric concentration of the principal greenhouse gases:

- 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.

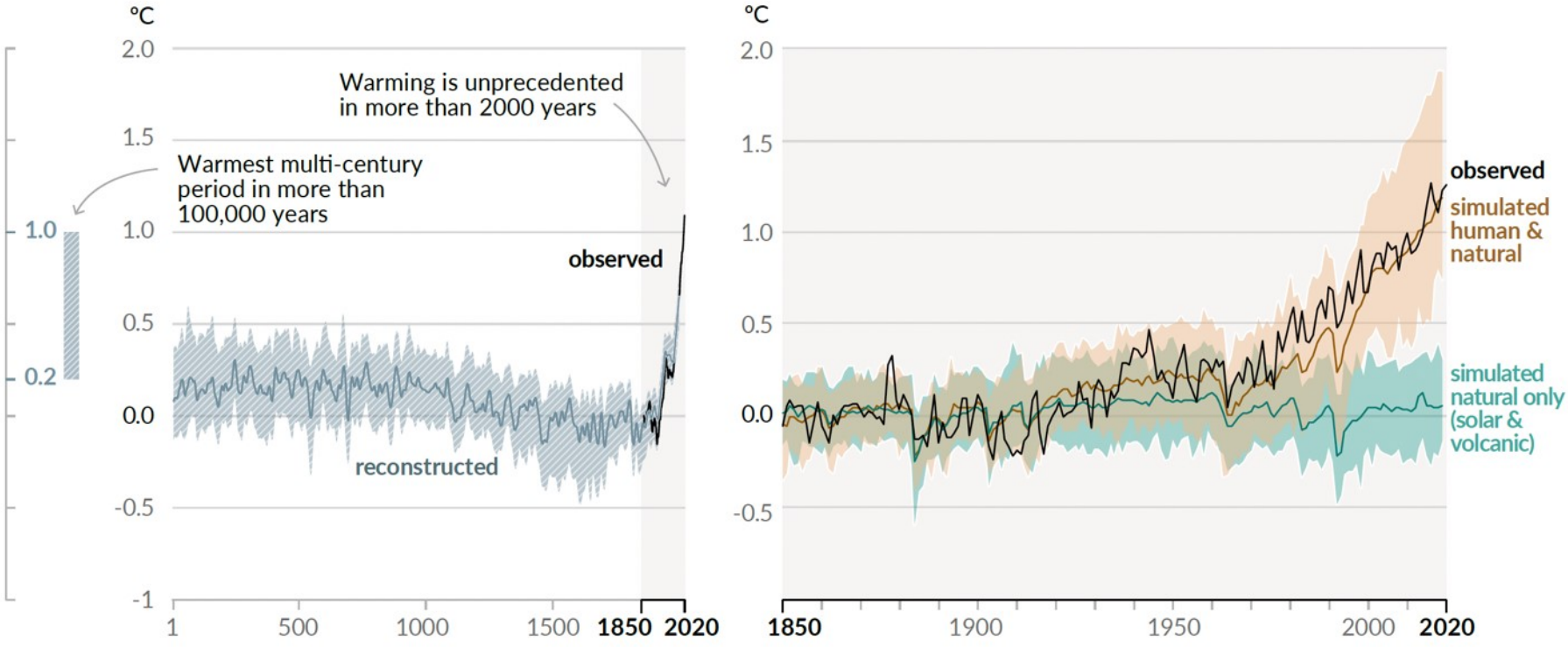
(IPCC 2013 WG1 Summary Report)

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

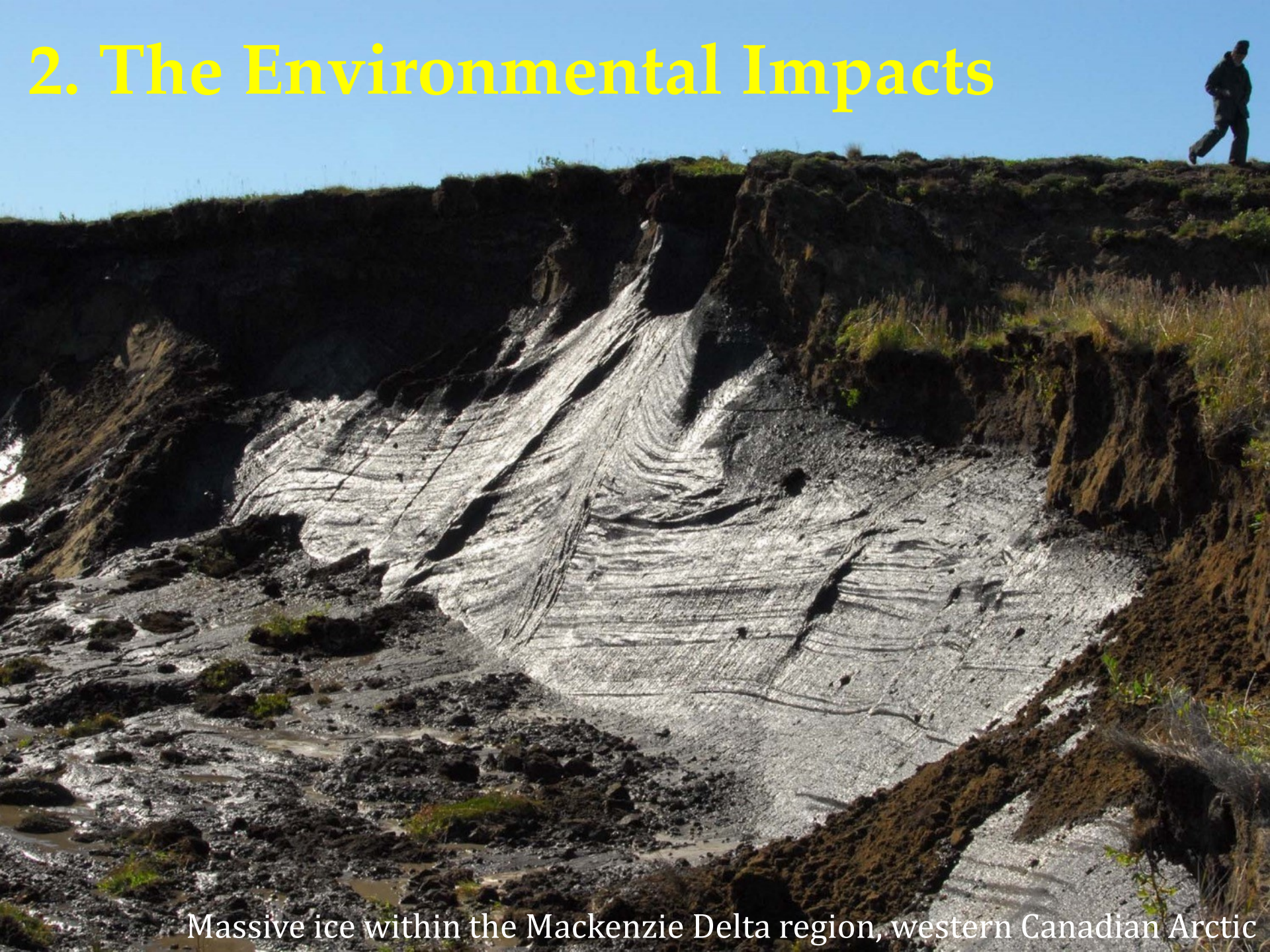
a) Change in global surface temperature (decadal average) as reconstructed (1-2000) and **observed** (1850-2020)

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



Climate Change 2021: The Physical Science Basis
(IPCC AR6 WR1, SPM-7)

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

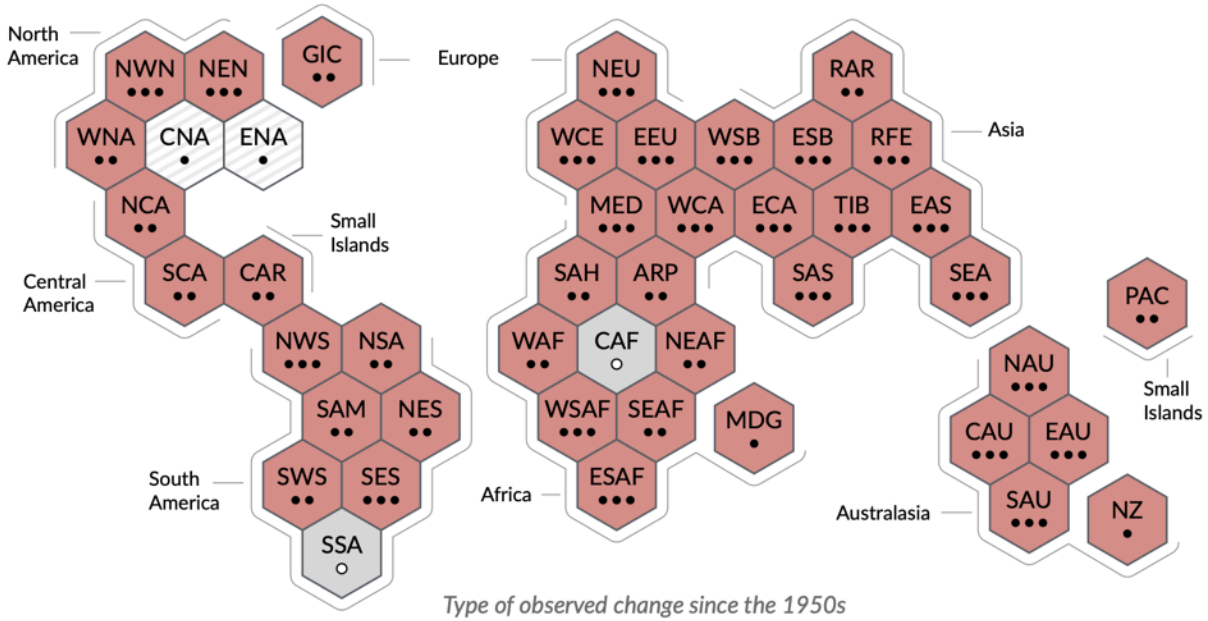
a) Synthesis of assessment of observed change in **hot extremes** and confidence in human contribution to the observed changes in the world's regions

Type of observed change
in hot extremes

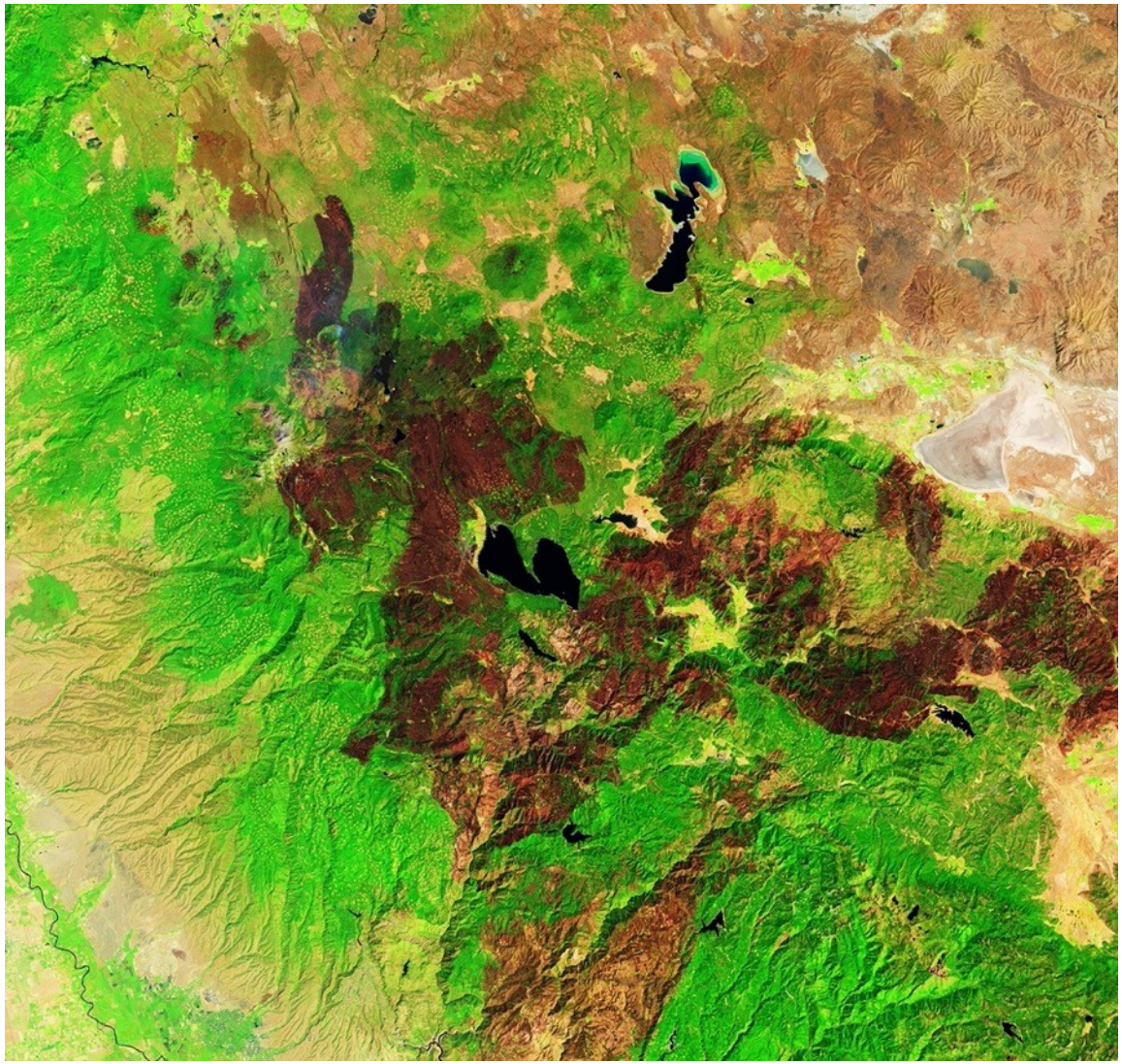
- Increase (41)
- Decrease (0)
- Low agreement in the type of change (2)
- Limited data and/or literature (2)

Confidence in human contribution
to the observed change

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



Climate Change 2021: The Physical Science Basis
(IPCC AR6 WR1, SPM-12)



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

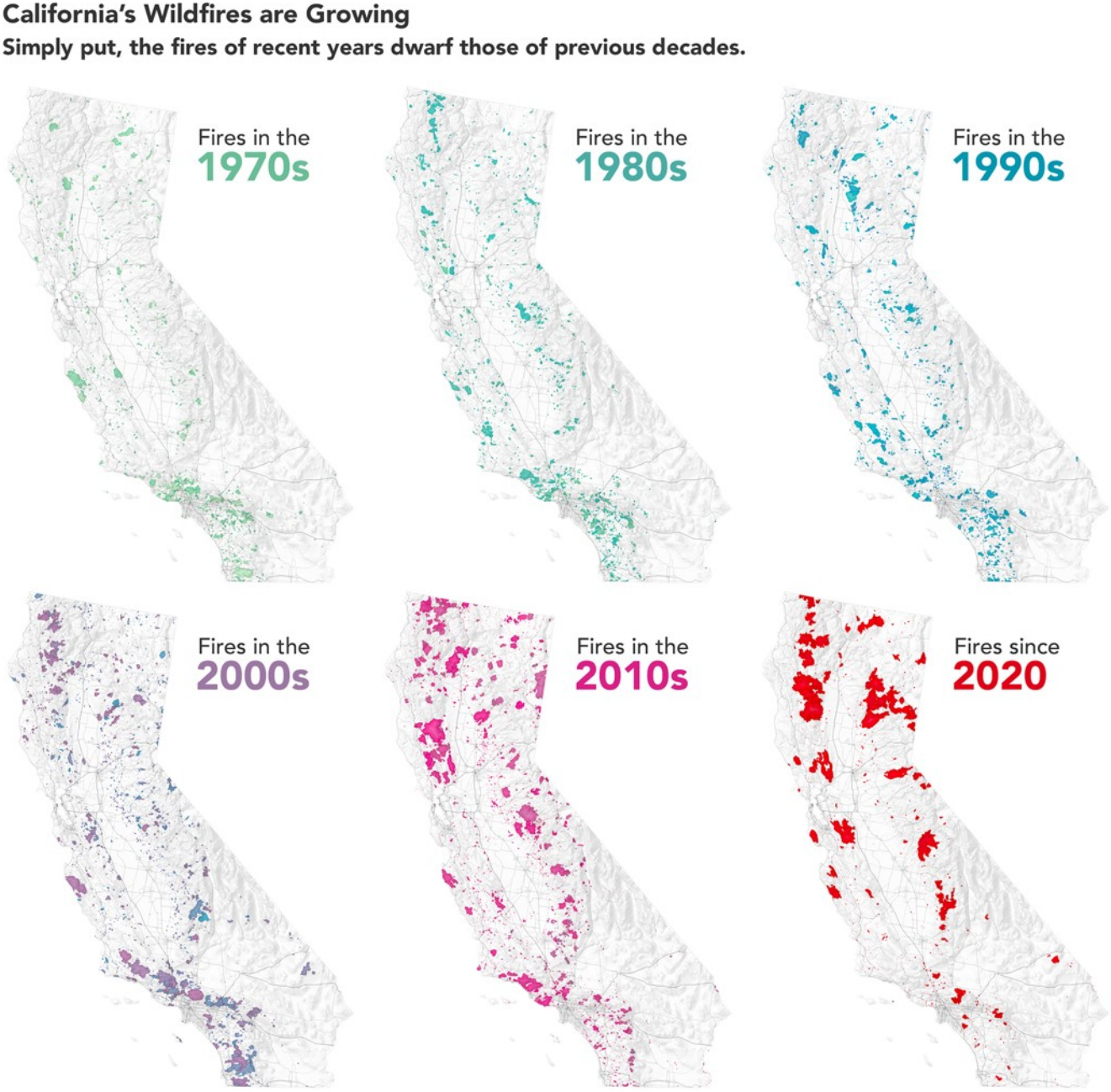
Wildfires

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

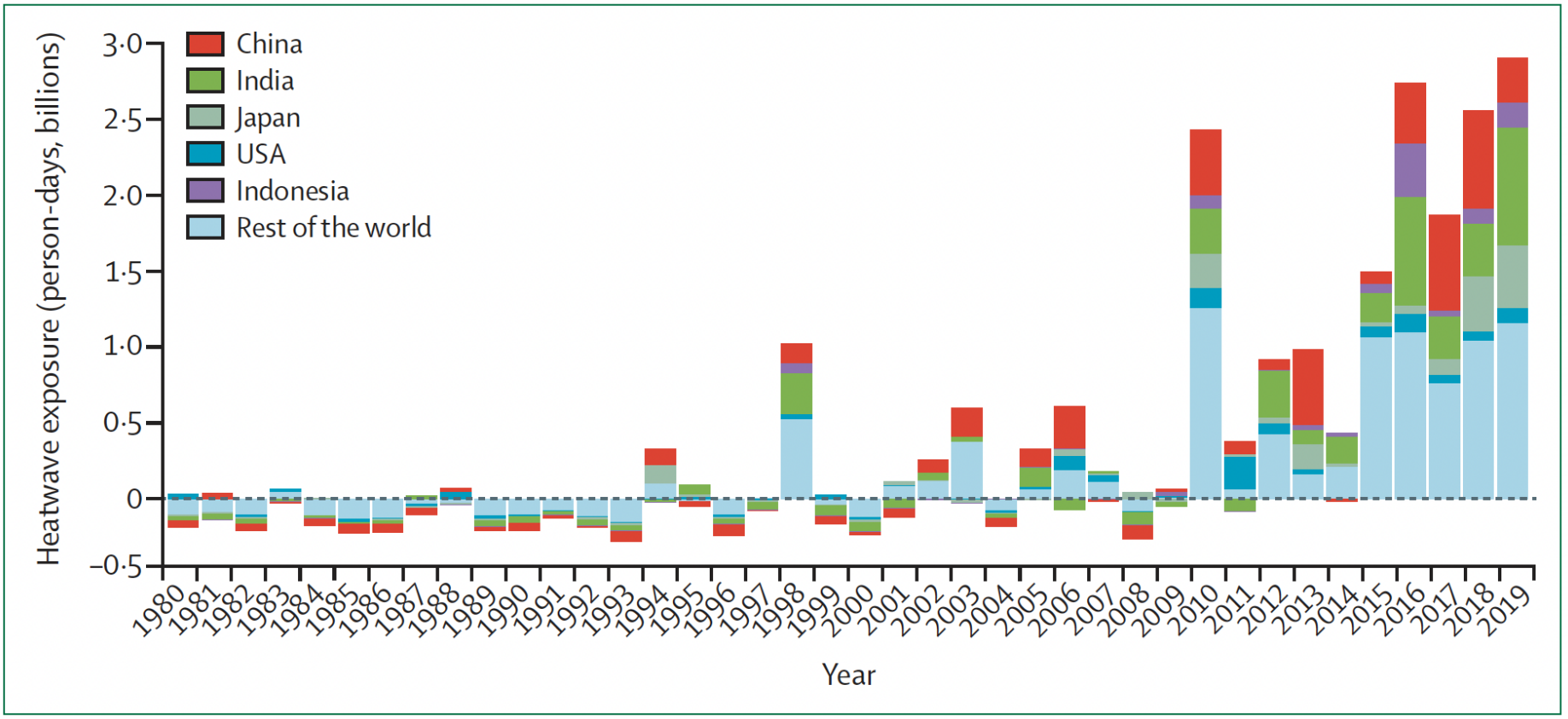
Burned 4% of California's total land area.

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

https://earthobservatory.nasa.gov/images/148908/whats-behind-californias-surge-of-large-fires

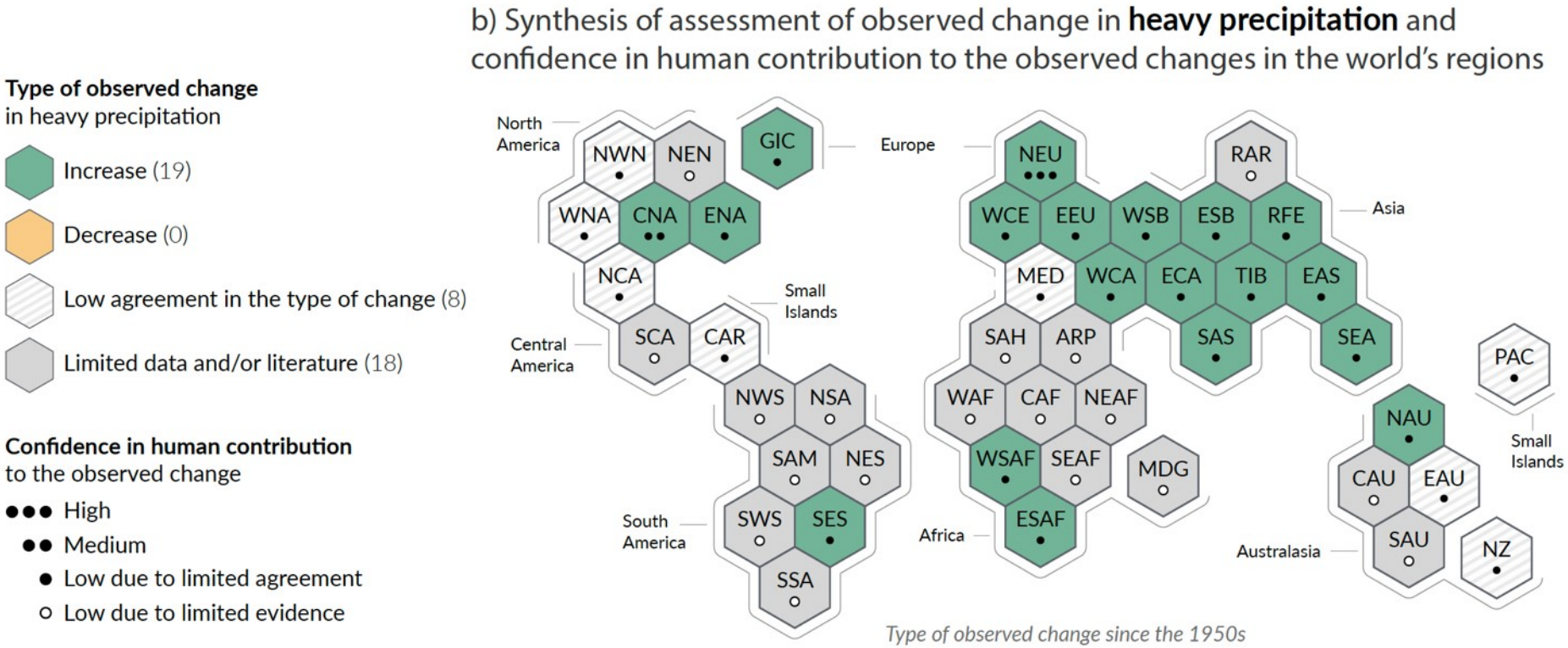


https://eoimages.gsfc.nasa.gov/images/imagerecords/148000/148908/californiafires_map_1970-2021_lrg.png



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.*



Climate Change 2021: The Physical Science Basis
(IPCC AR6 WR1, SPM-12)

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

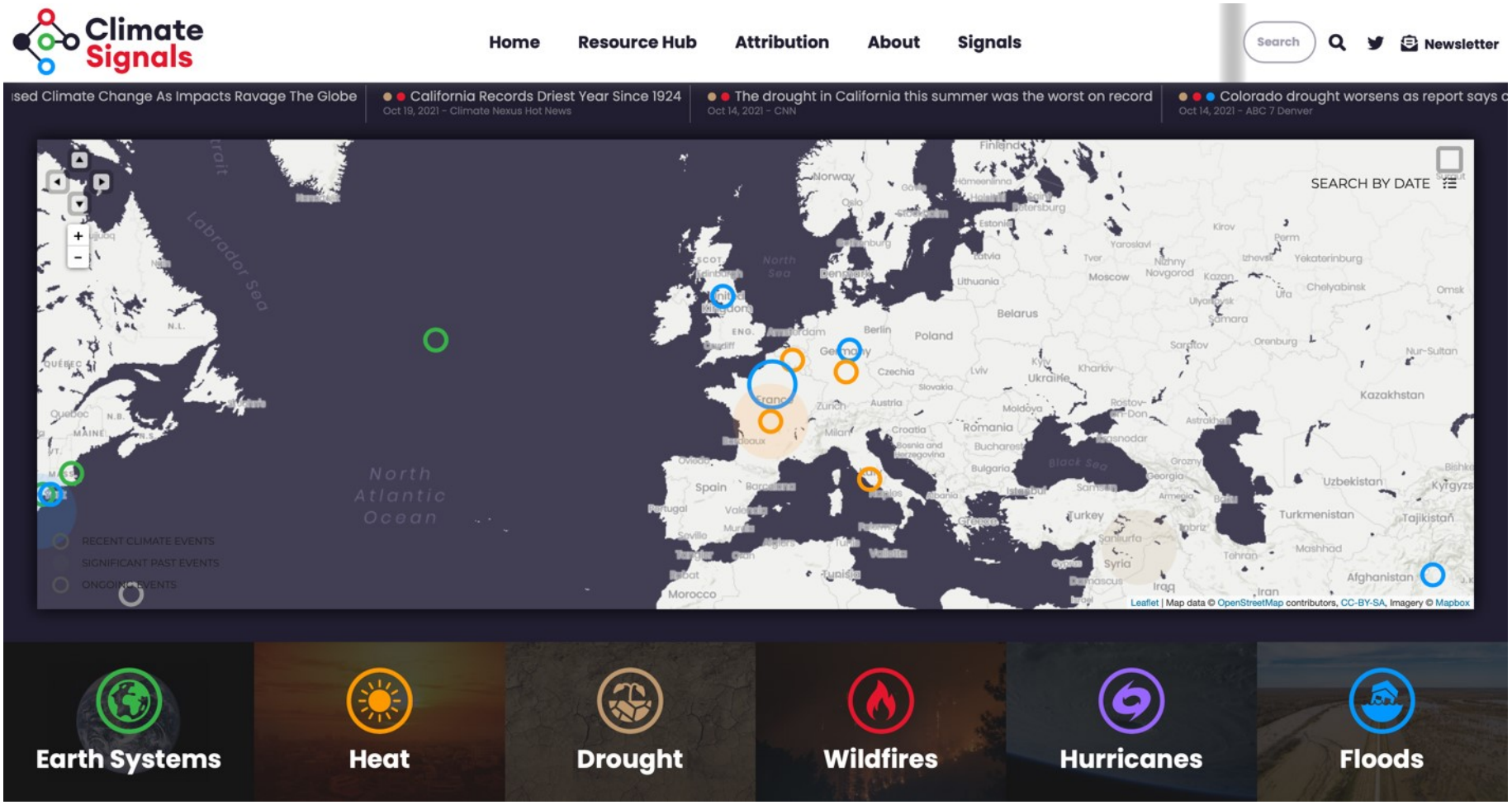
15 July

The deadly floods have left homes and cars destroyed

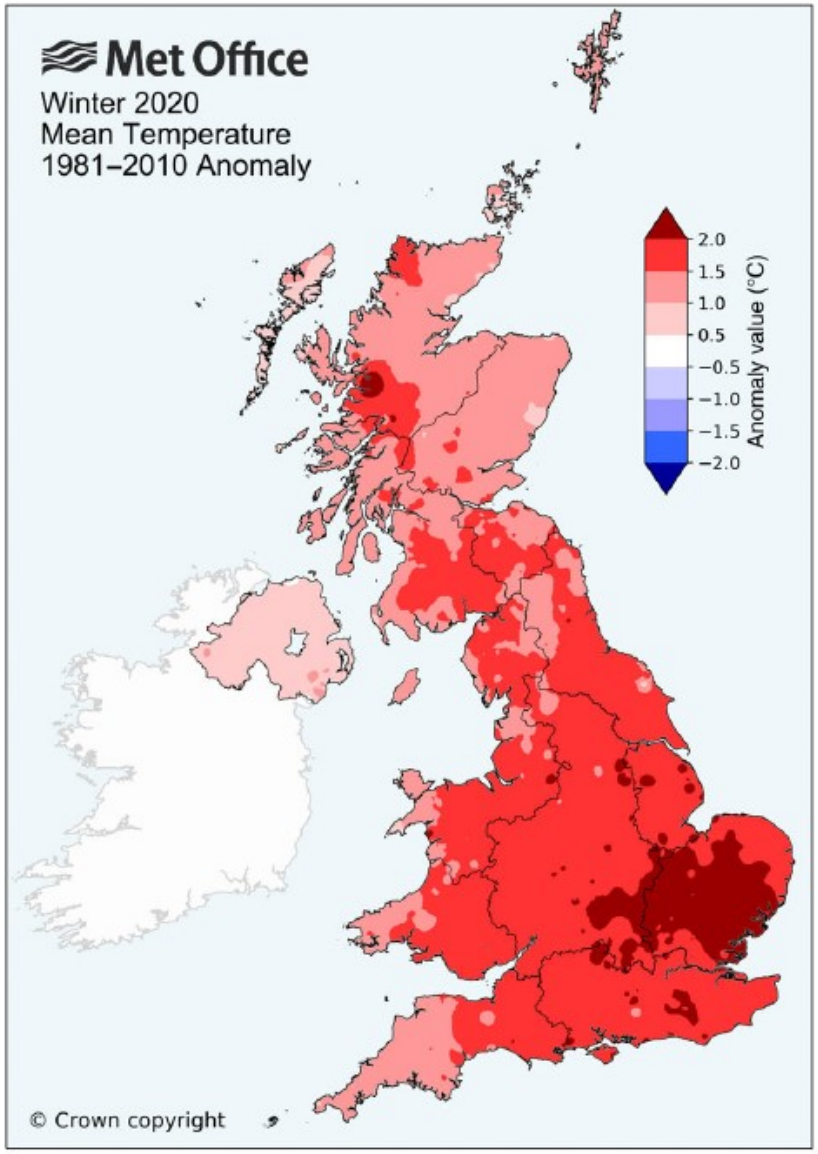
At least 70 people have died in Germany and Belgium after record rainfall caused rivers to burst their banks.

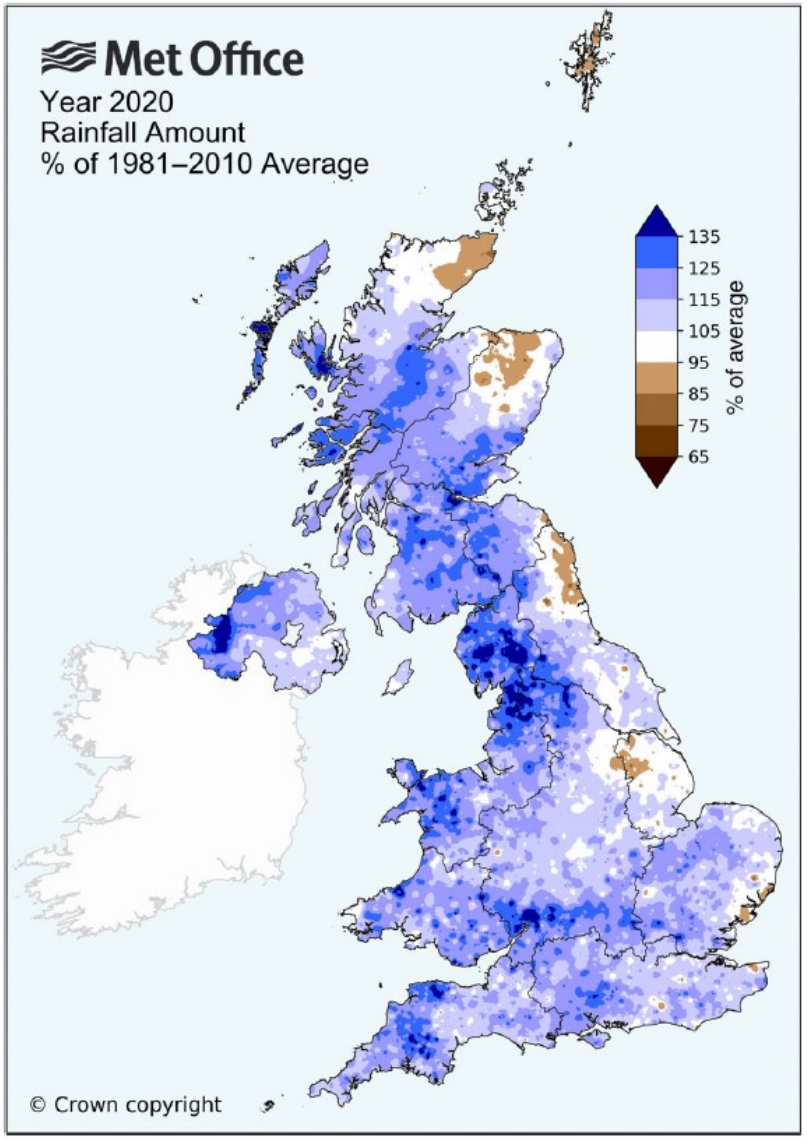
Most of the victims were in Germany, but at least 11 have died in Belgium, with more reported missing.

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

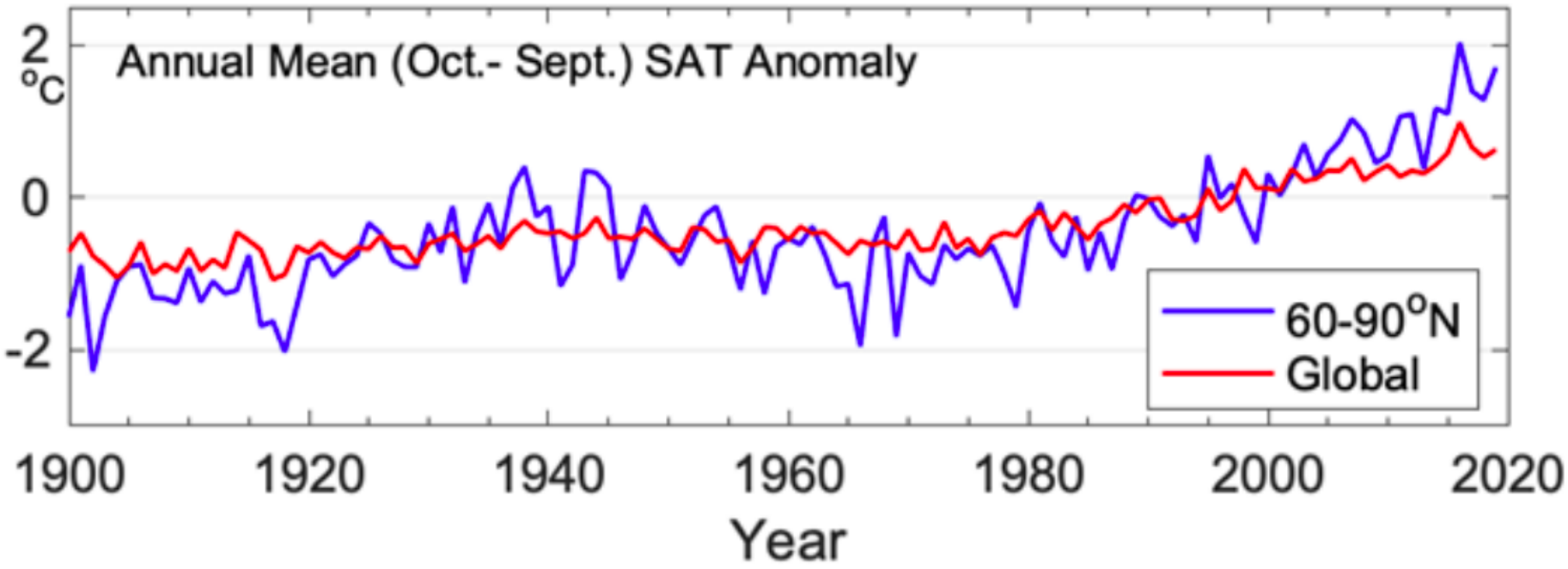


Growth in research into "climate attribution" and the connections between longer-term climate change and extreme weather events.
https://www.climatesignals.org





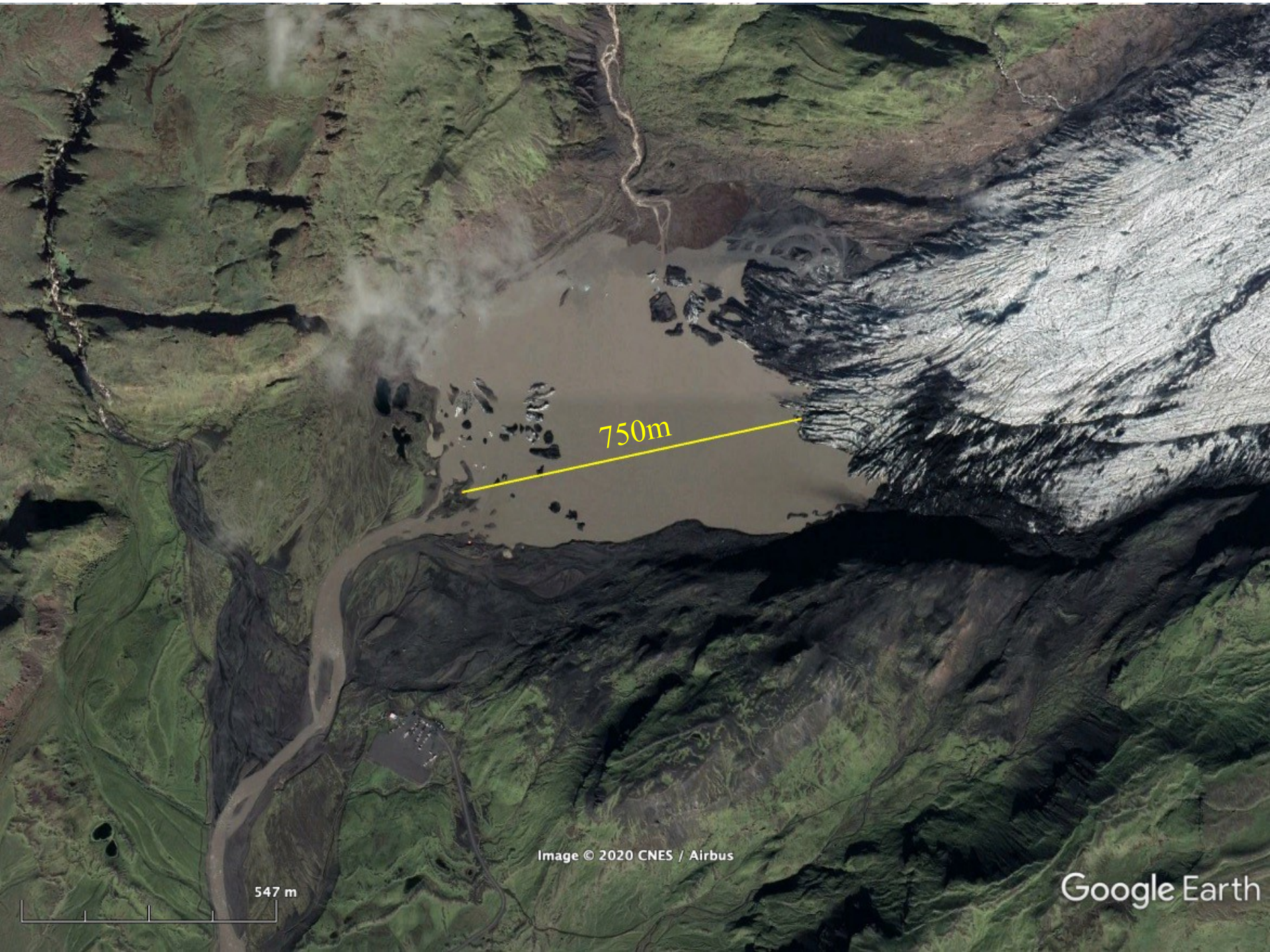
Kendon, M., McCarthy, M., Jevrejeva, S., Matthews, A., Sparks, T. and Garforth, J., 2021. State of the UK Climate 2020. *International Journal of Climatology*, *41*, pp.1-76.



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 1.9ºC higher than the 1981-2010 mean.

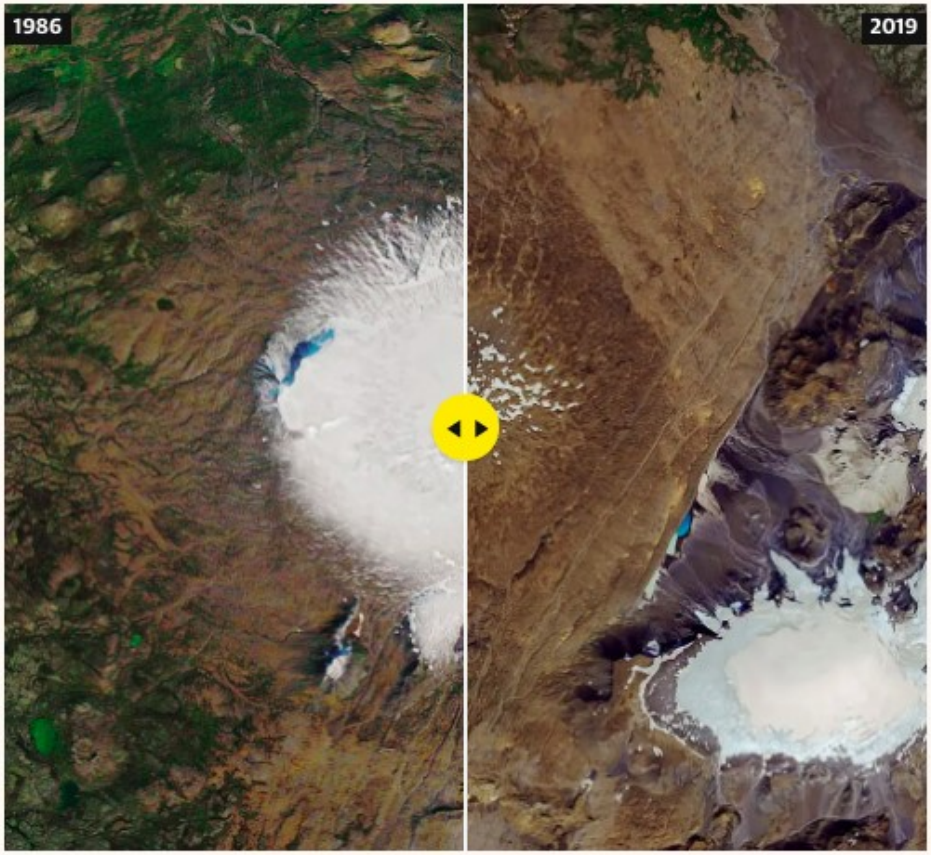
NOAA Arctic Report Card, p6


750m
Image © 2020 CNES / Airbus
547 m
Google Earth

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

Andri Snær Magnason

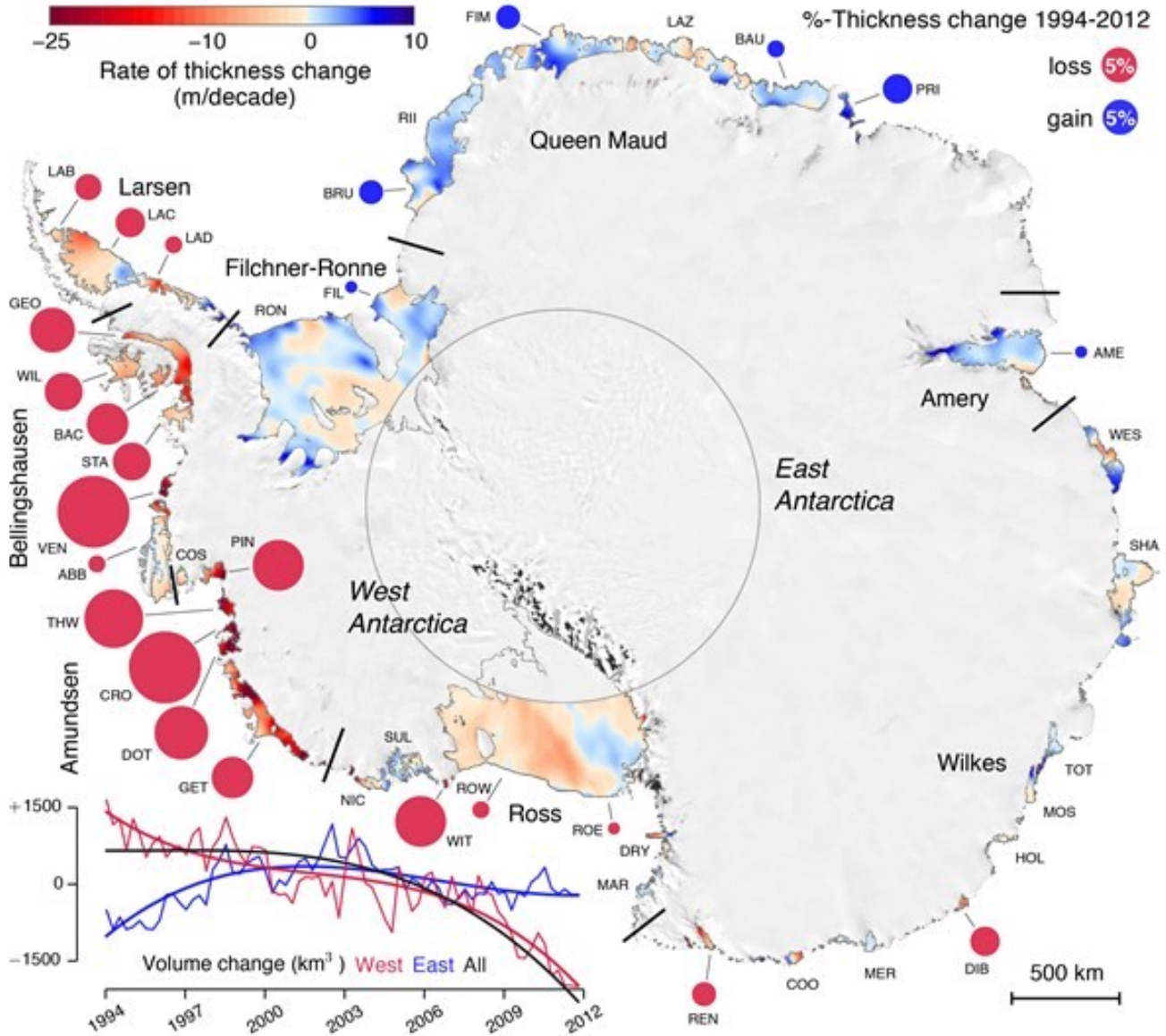
My grandparents mapped these giants of the landscape. A plaque will mark the spot where the first was lost to the climate crisis



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

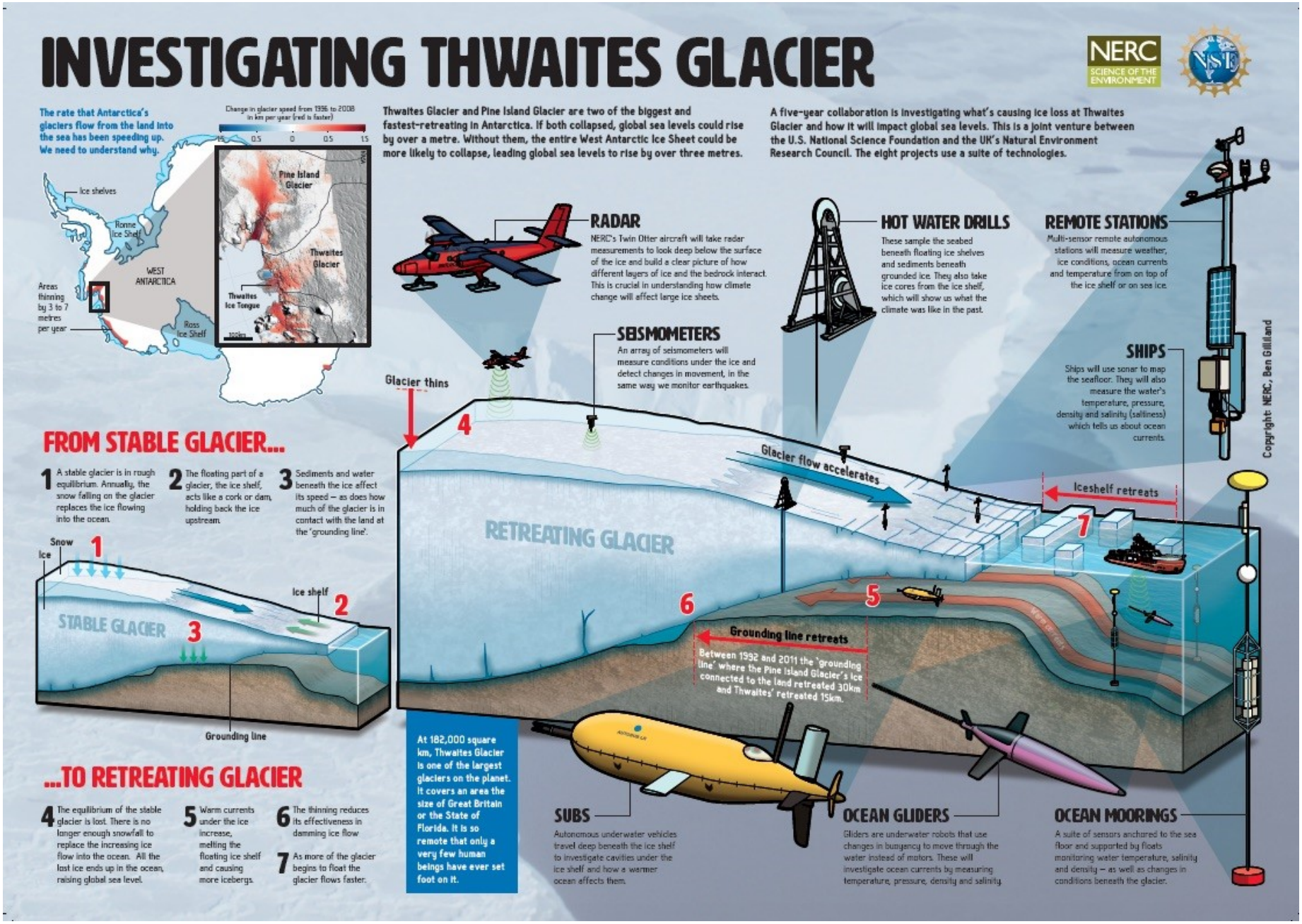
https://landsat.gsfc.nasa.gov/tribute-to-a-glacier-that-is-no-more/

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

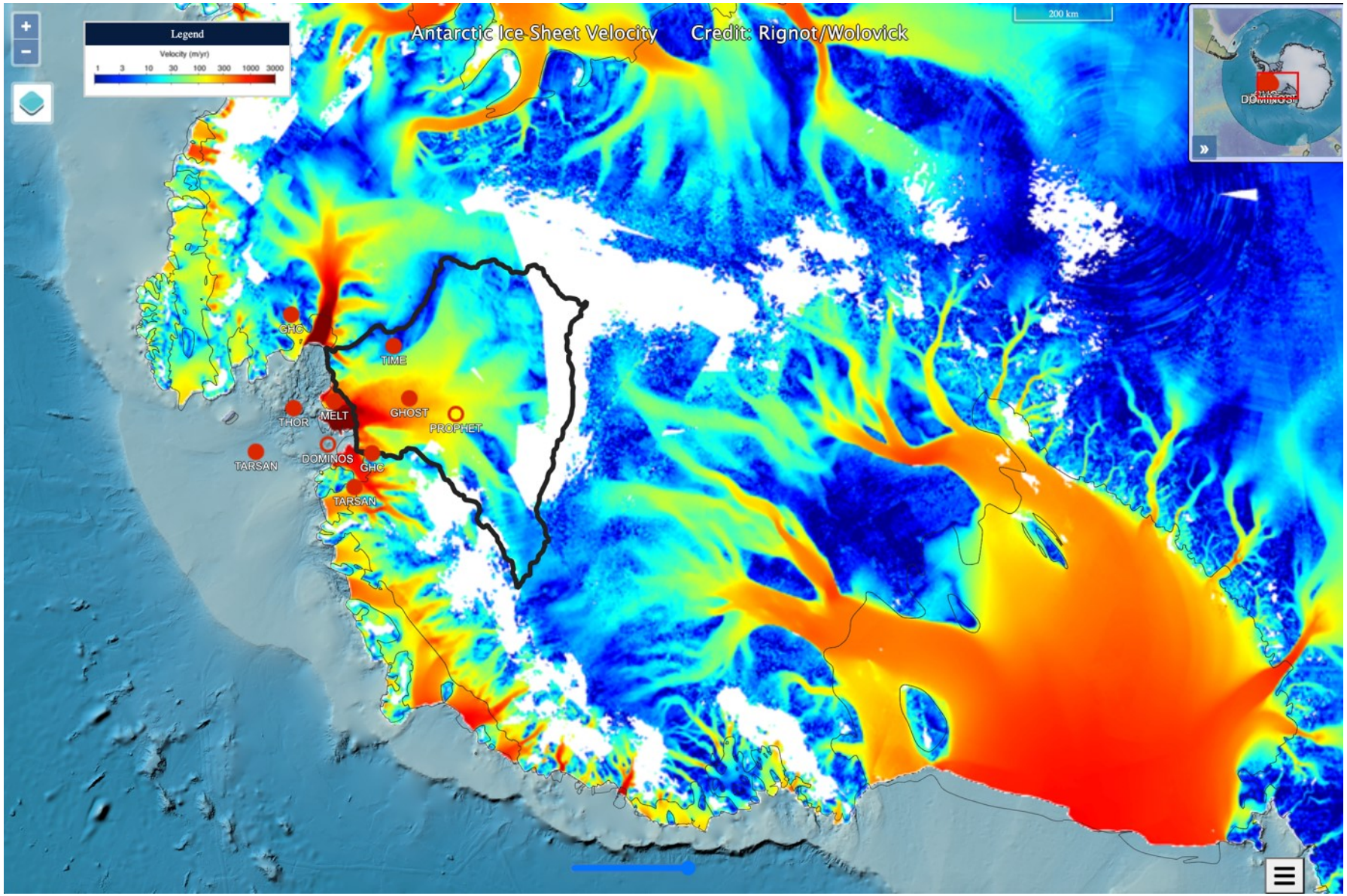


Change in the thickness of ice shelves between 1994 – 2012.

Paolo, F.S. *et al.*, 2015. Volume loss from Antarctic Ice Shelves is accelerating. *Science*, 348, p328.

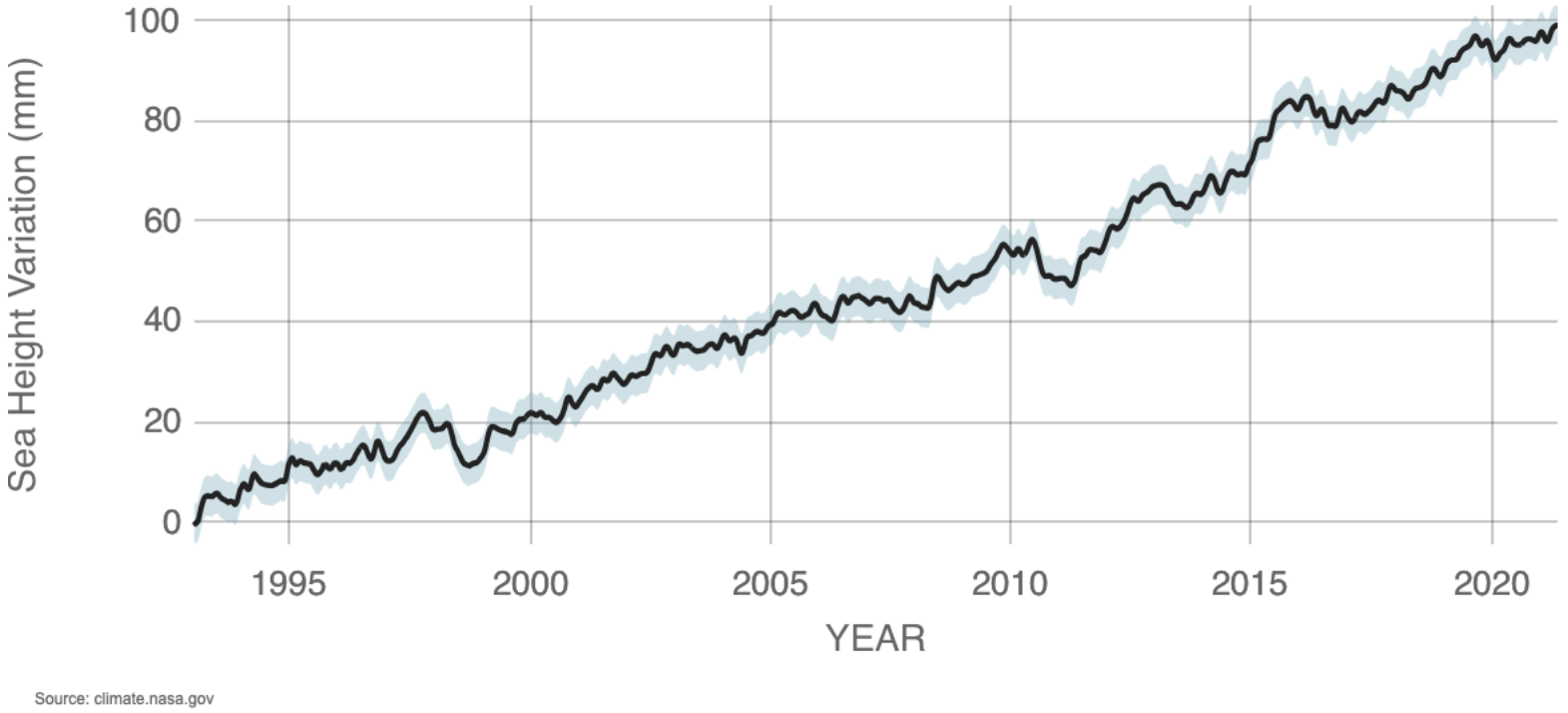


https://thwaitesglacier.org/sites/default/files/2019-03/edu-infog-2-2019.jpeg



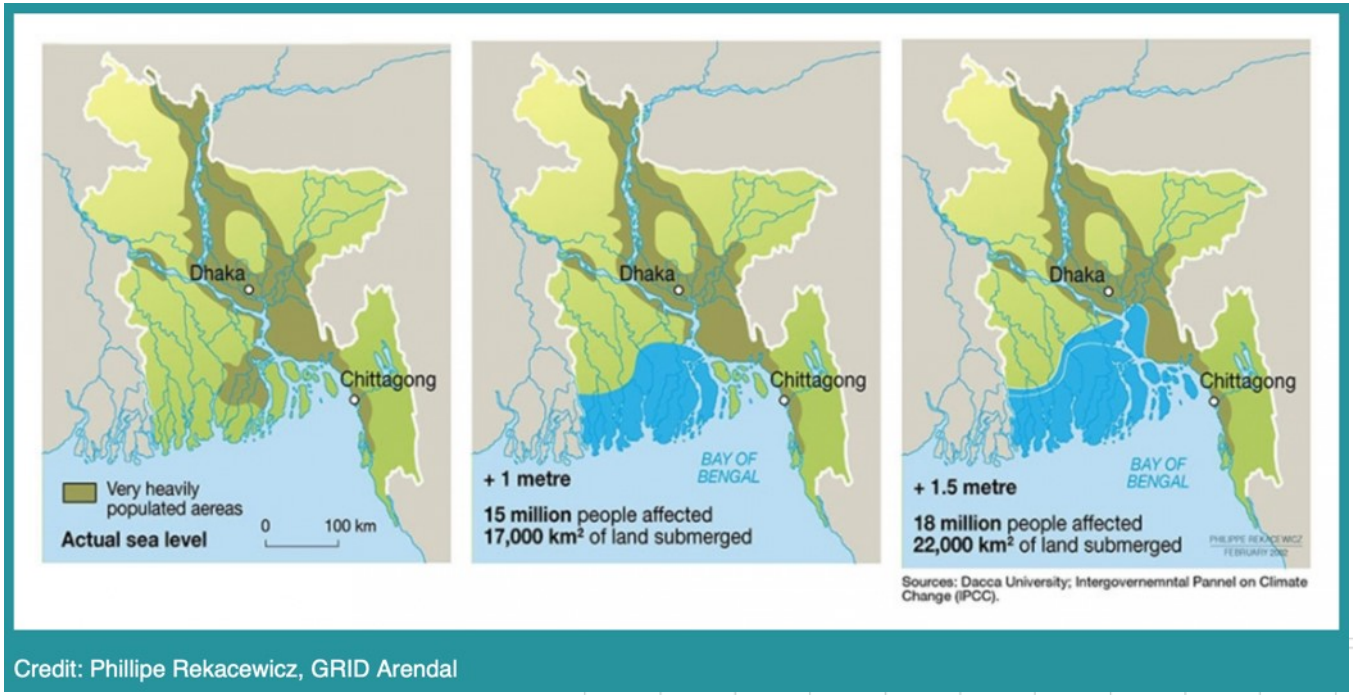
Acceleration of the glacier margin to >3km/yr leading to an estimated ice loss of 125 billion tons per year.

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

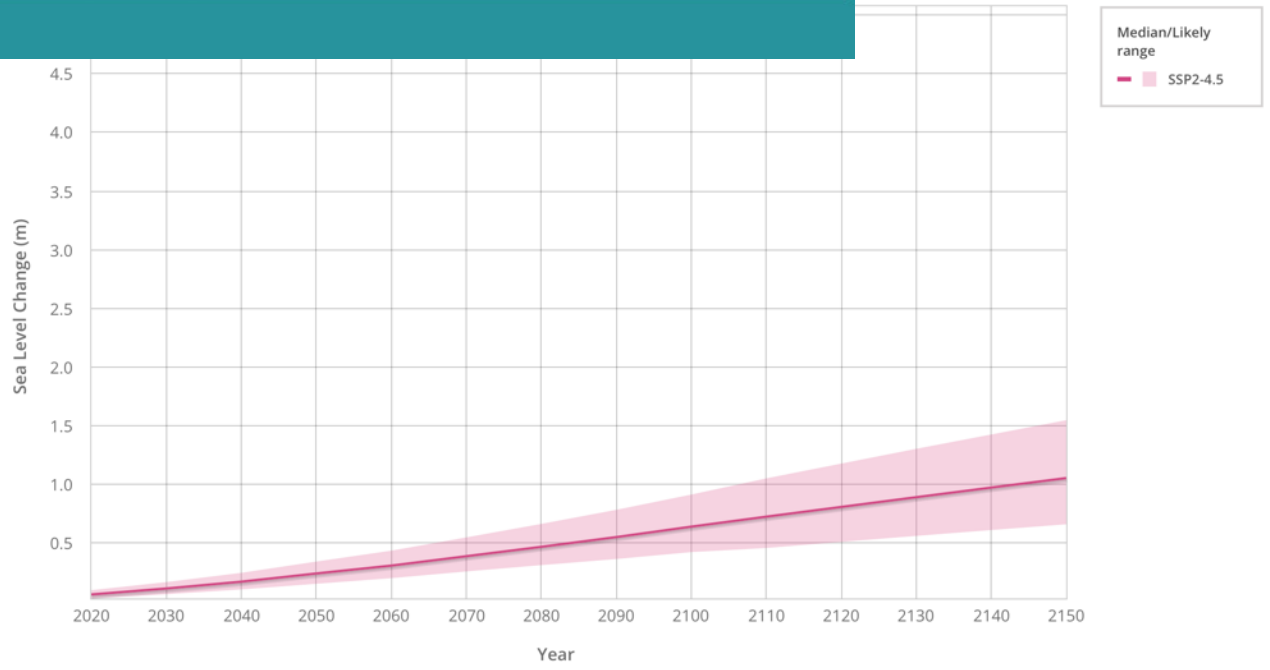


"Global sea levels are rising as a result of human-caused global warming, with recent rates being unprecedented over the past 2,000-plus years."

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

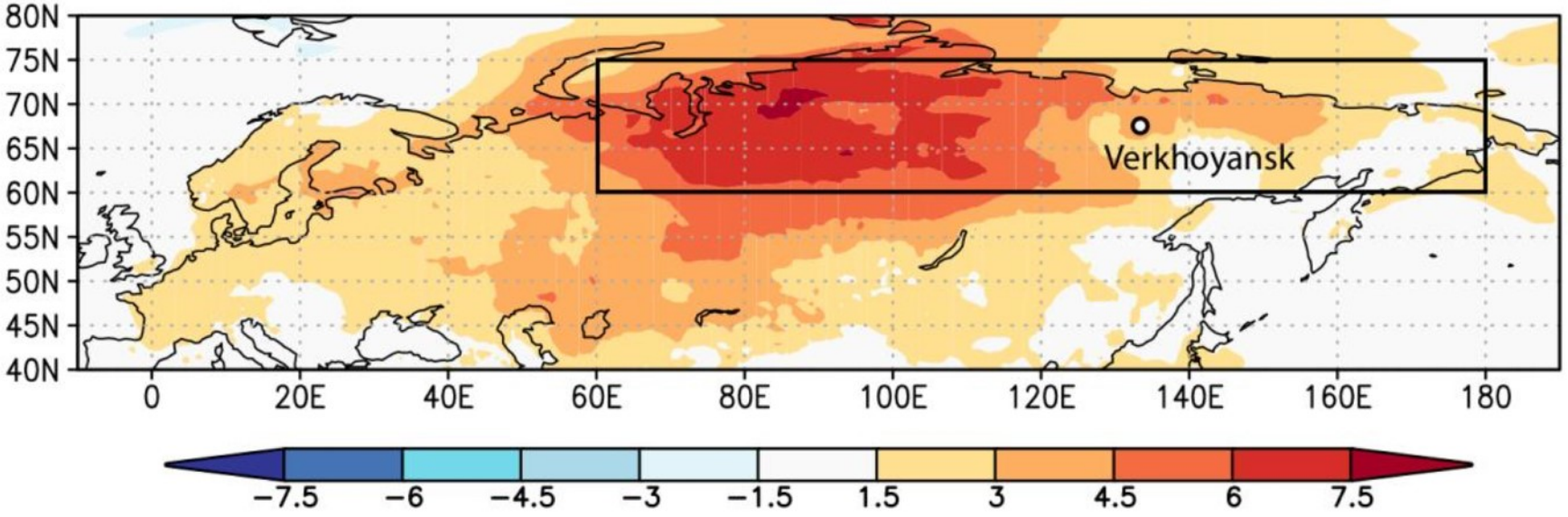


https://scied.ucar.edu/image/sea-level-change-bangladesh



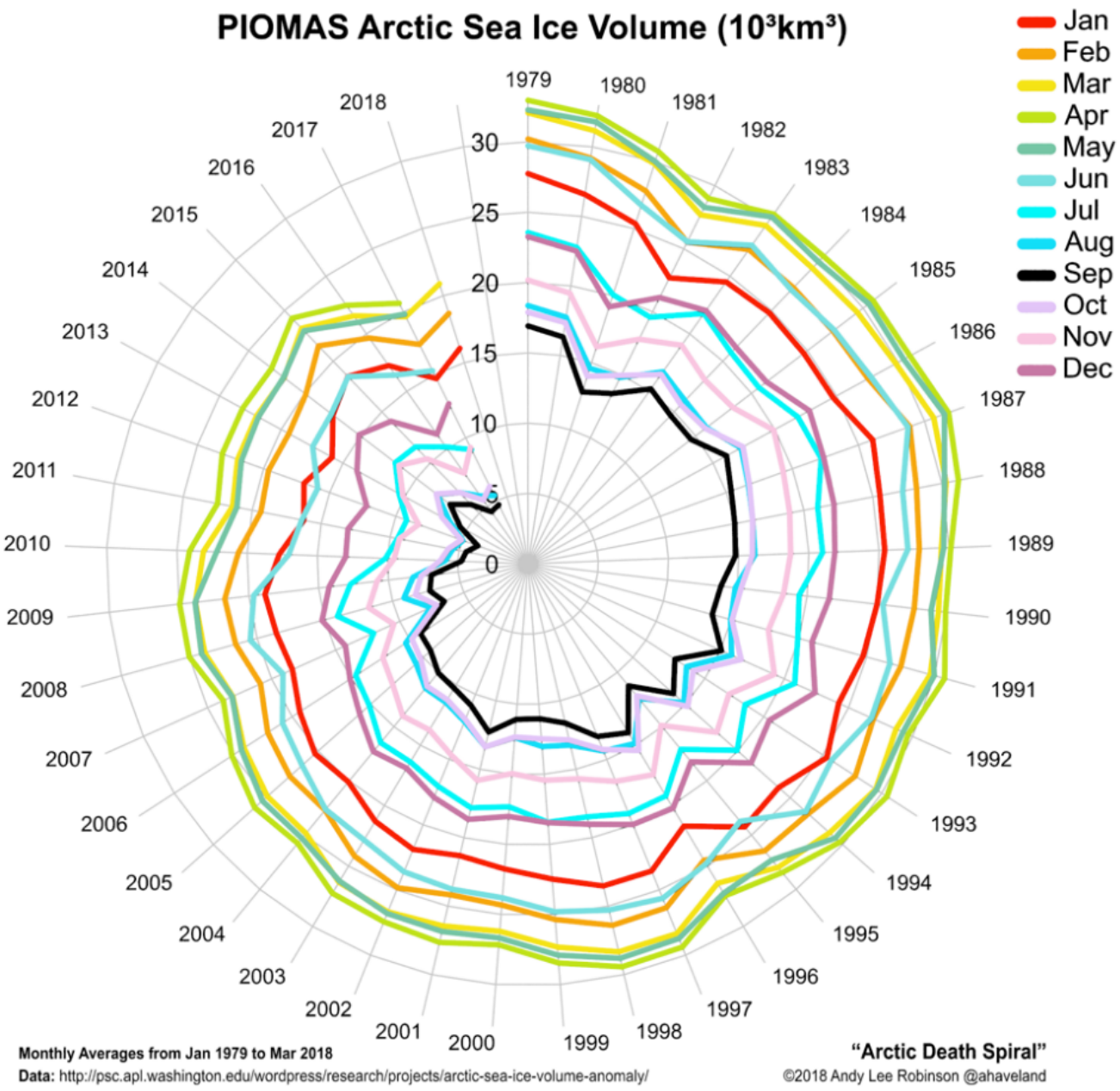
https://sealevel.nasa.gov/ipcc-ar6-sea-level-projection-tool?psmsl_id=1451

Record breaking Arctic Temperatures



- Early summer 2020 – first time temperatures of >100ºF (38ºC) have been recorded in the Arctic.
- Average temperatures in the first half of the year 6ºC higher than normal (1981-2010).
- Considered directly attributable to climate change.

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

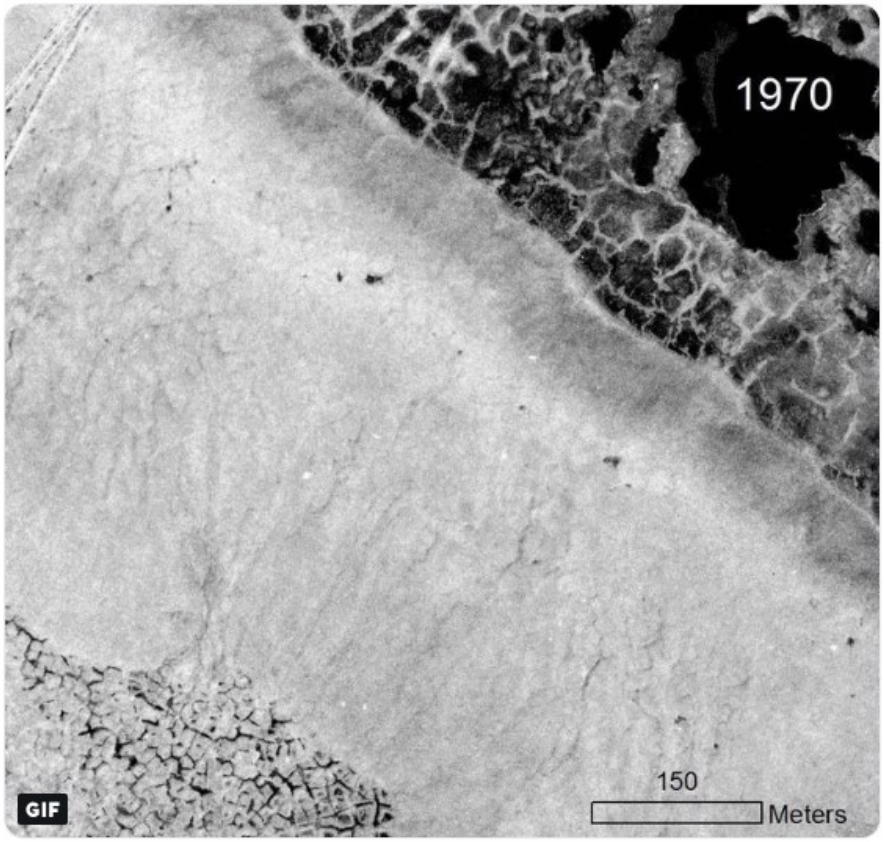


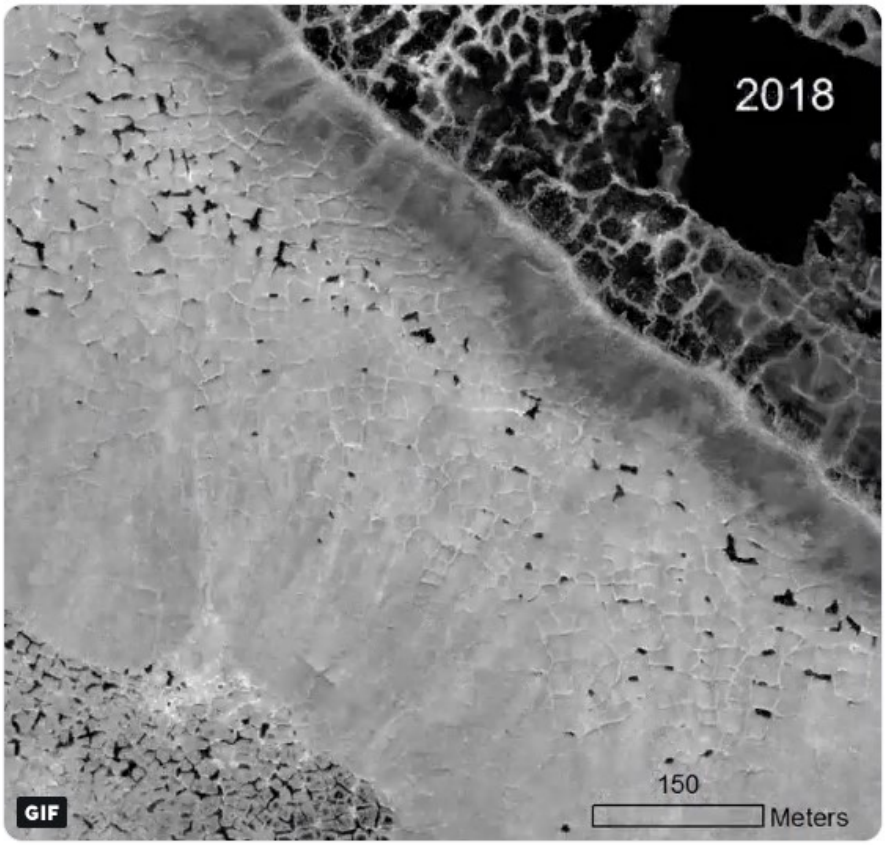
https://haveland.com/share/arctic-death-spiral.png

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.





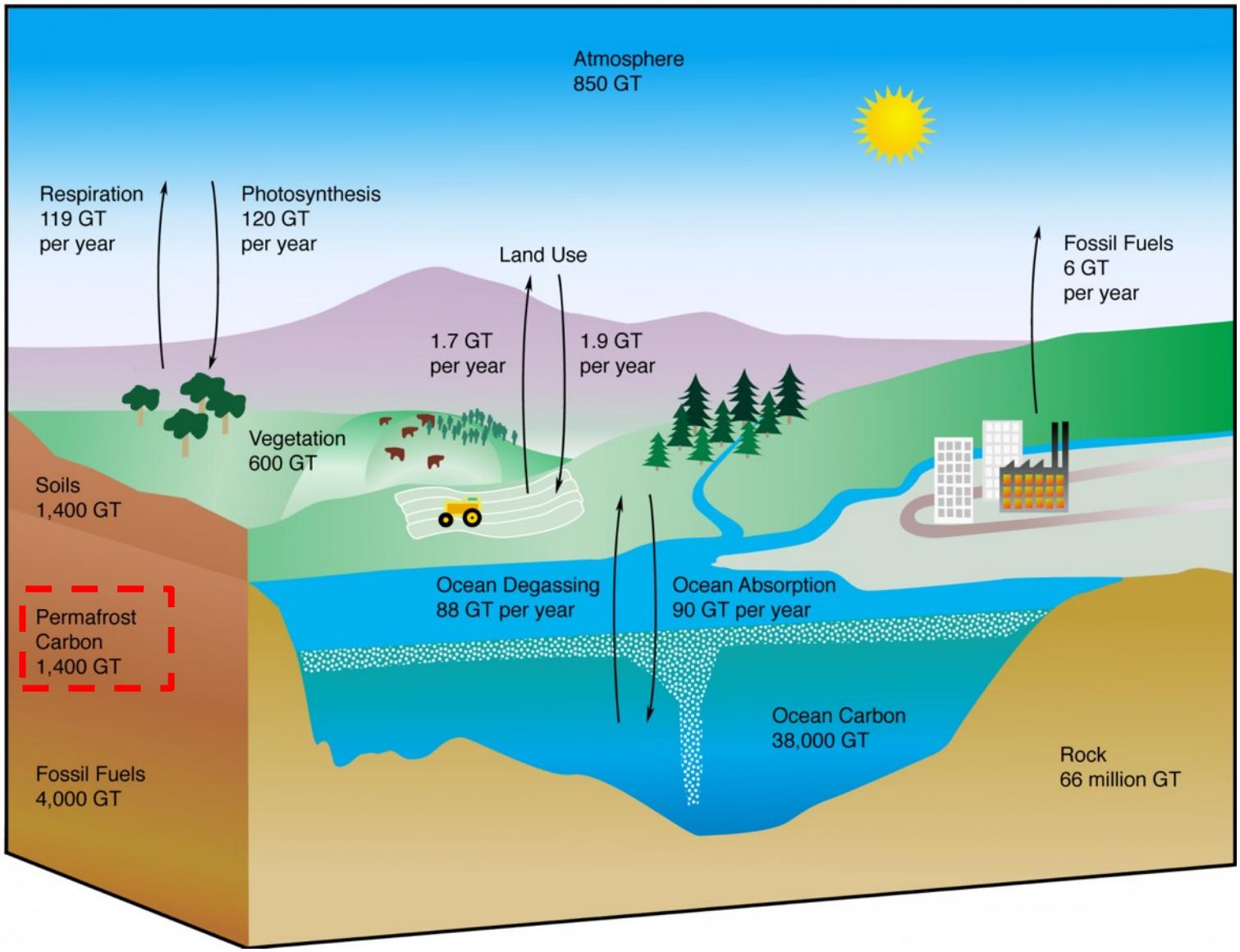
8:02 PM - 25 Jan 2019

39 Retweets **70** Likes

4 39 70

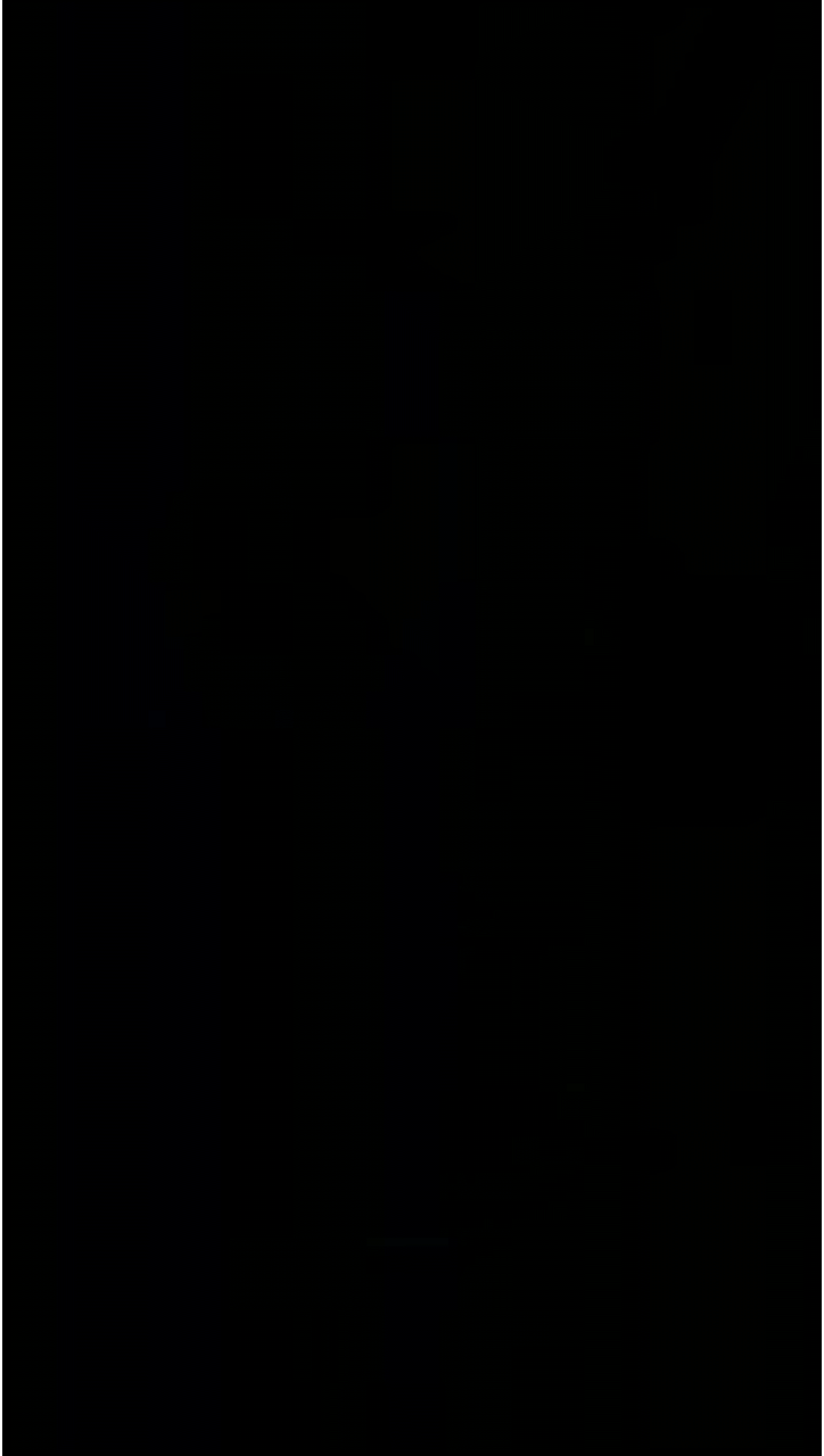
https://twitter.com/EOArctic/status/1088889768417640448

Conservative estimates suggest that 136,000 km^2 of this study area is affected by these landscape disturbances with their extent increasing rapidly over time.

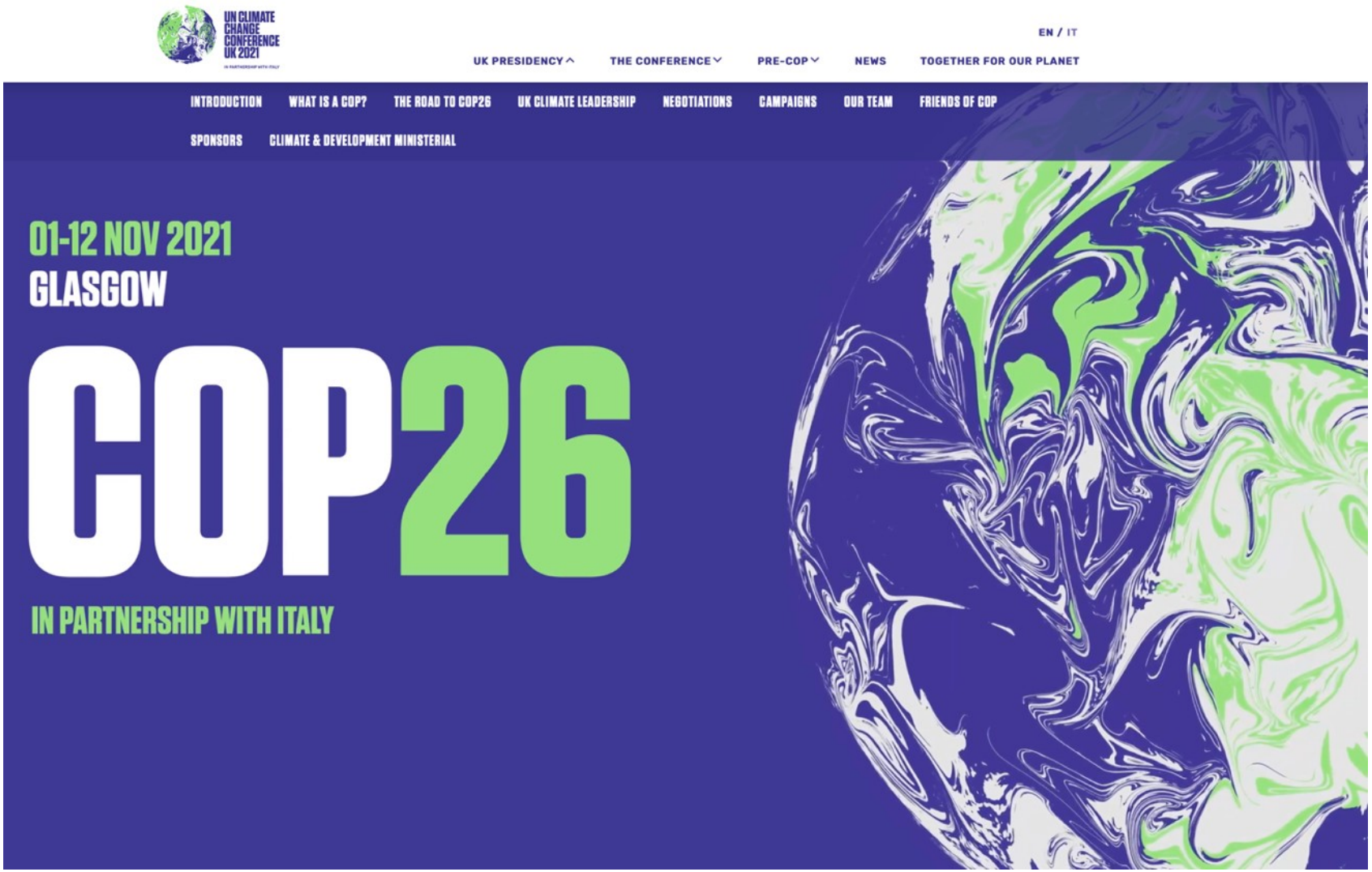


Global carbon stores and fluxes: Note how much carbon is estimated to be stored in permafrost alone - more than the carbon currently in the atmosphere. https://nsidc.org/cryosphere/frozenground/methane.html

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



3. Carbon Budgets & COP 26



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

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

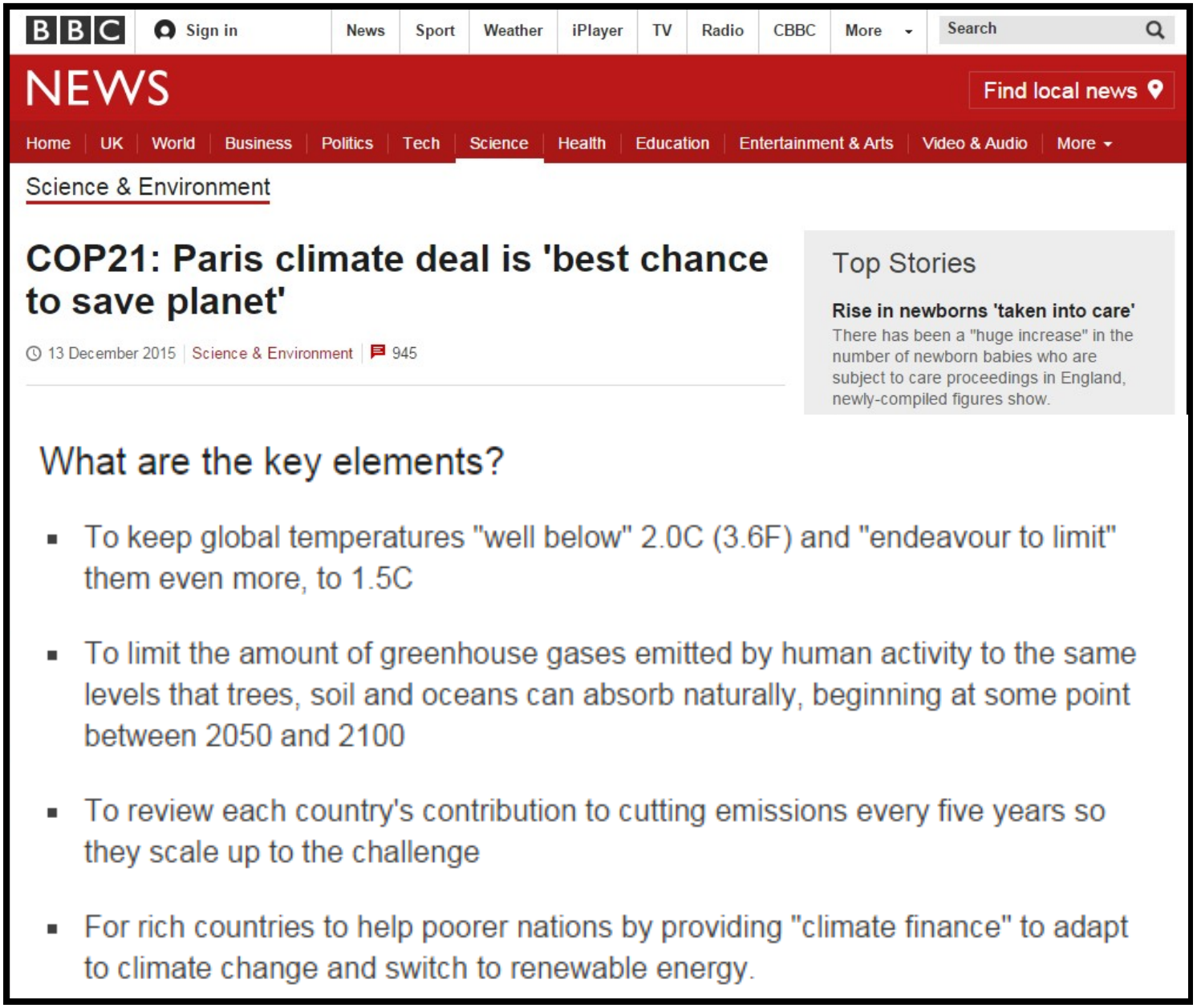
For example, if just one flood broke through the Thames Barrier it would cost around £30bn in damage to London, roughly 2% of GDP.

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.

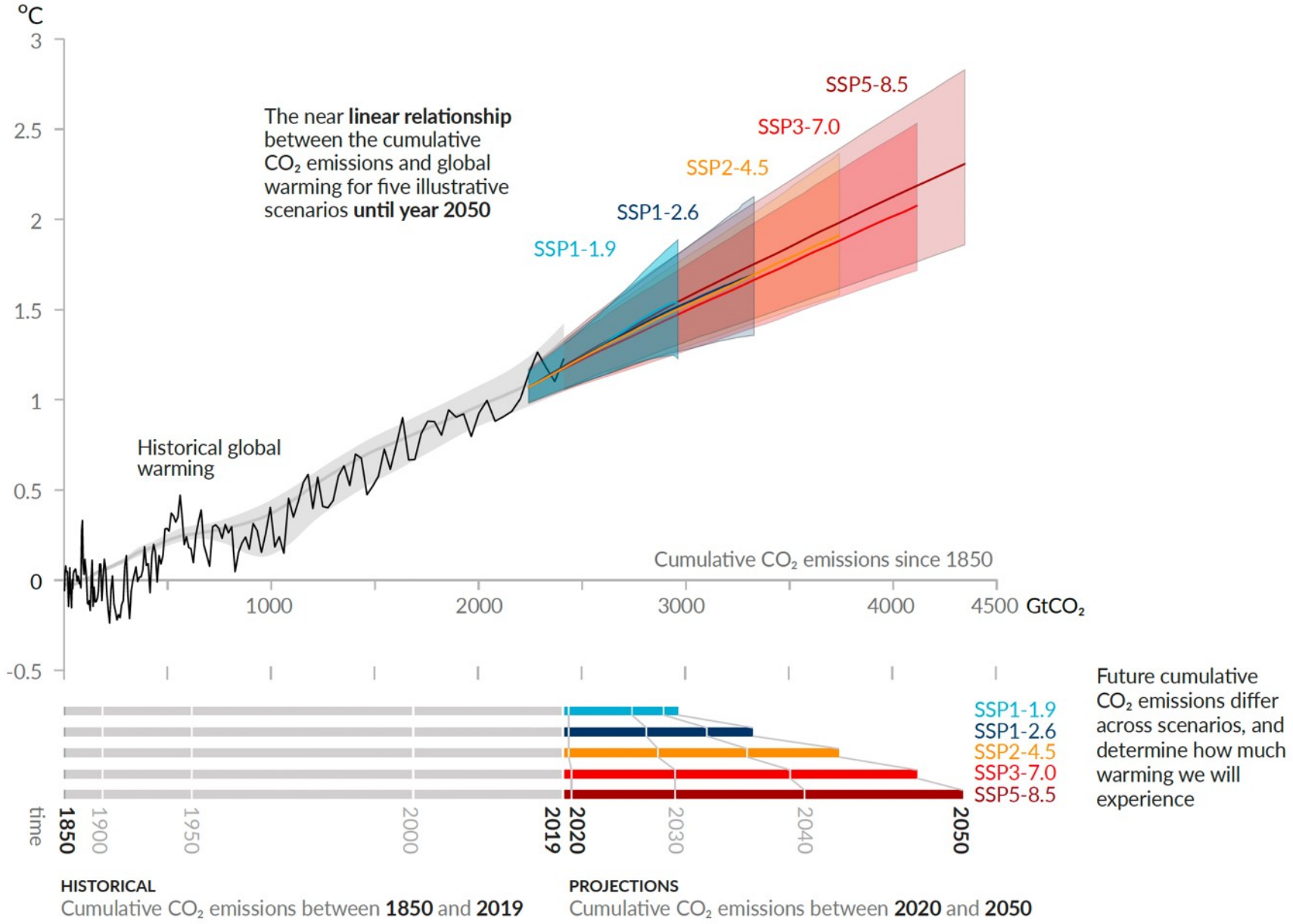
The Guardian, 9 January 2004



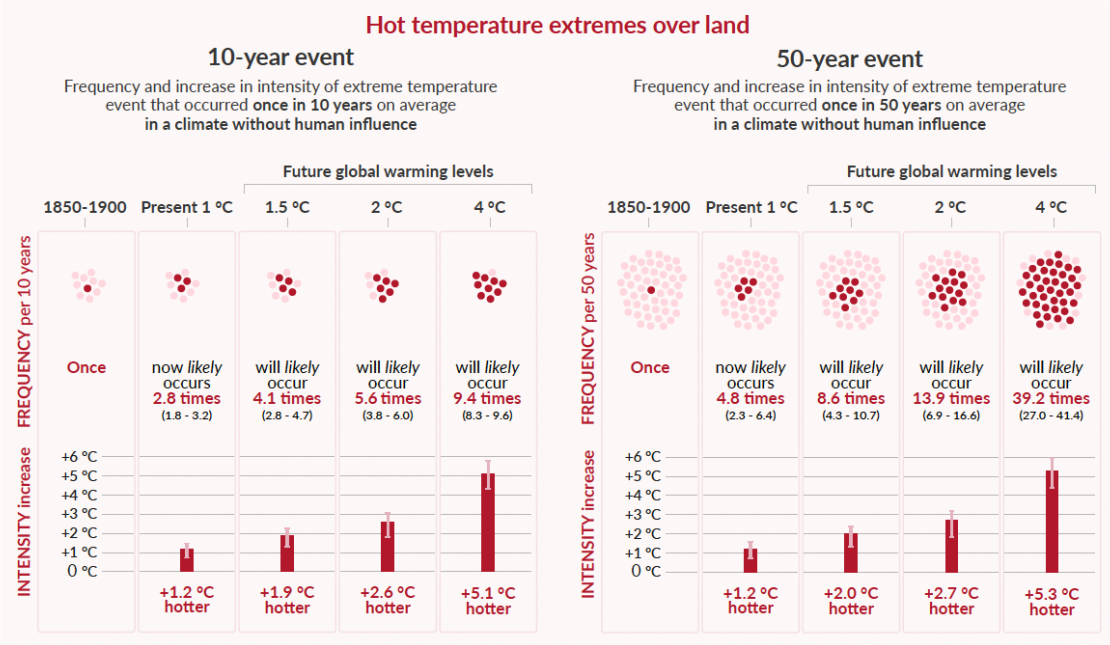
http://www.bbc.co.uk/news/science-environment-35086346

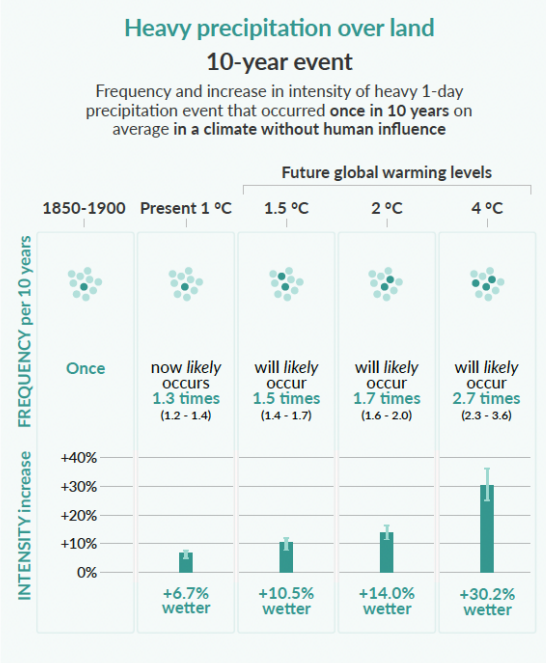
Every tonne of CO_2 emissions adds to global warming

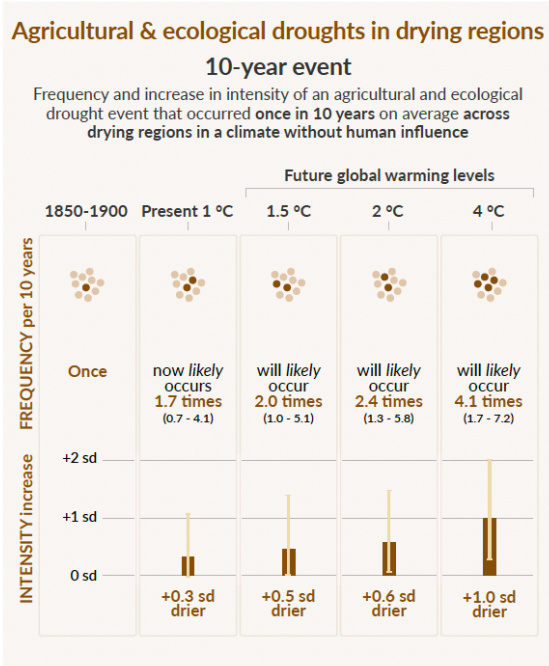
Global surface temperature increase since 1850-1900 (°C) as a function of cumulative CO_2 emissions ($GtCO_2$)



Future cumulative CO_2 emissions differ across scenarios, and determine how much warming we will experience

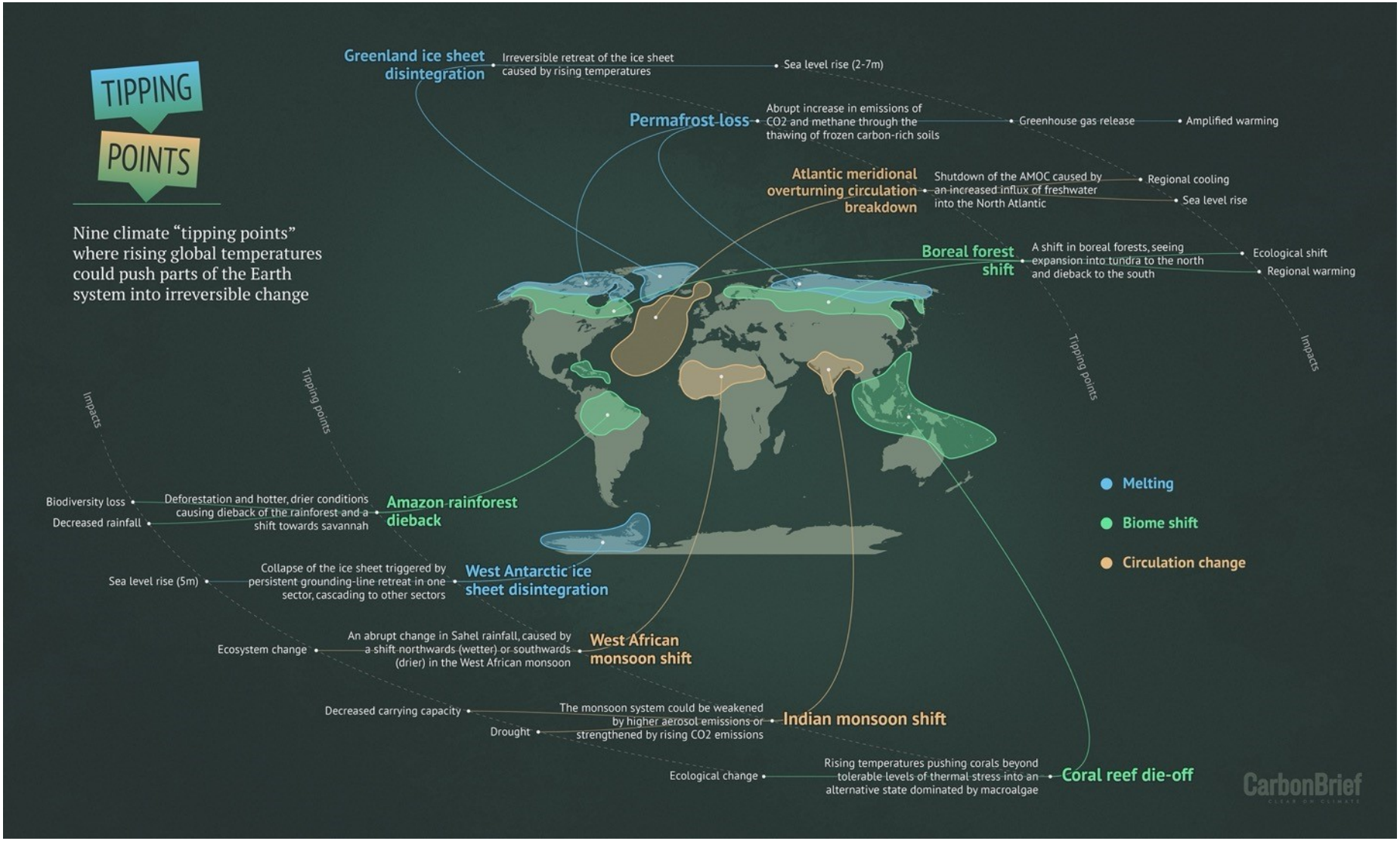






Severity of the impacts of climate change increase proportionately with the increase in temperature

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



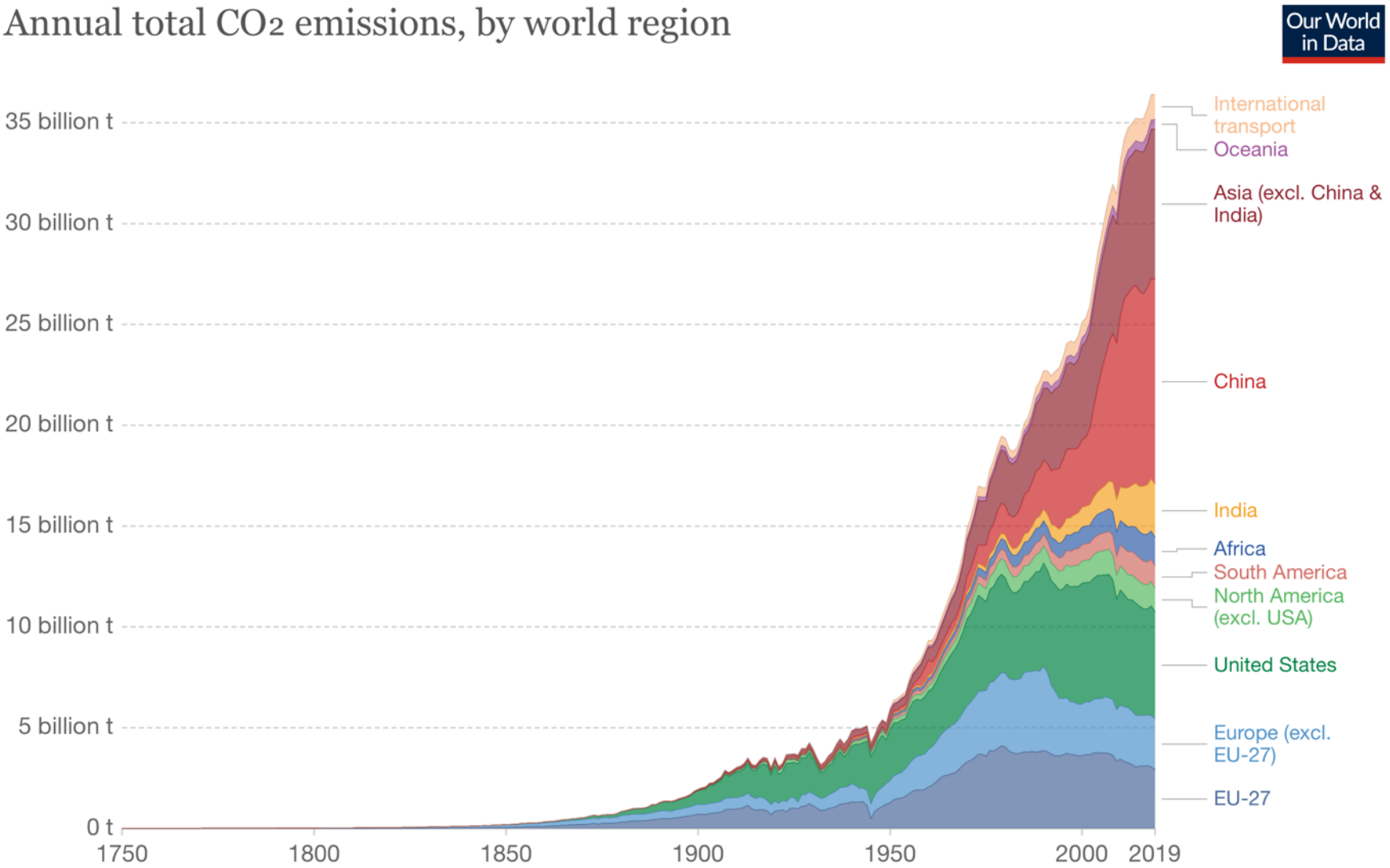
https://www.carbonbrief.org/explainer-nine-tipping-points-that-could-be-triggered-by-climate-change

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; *likely* range)	2390 (± 240; *likely* 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 *($GtCO_2$)* — *Likelihood of limiting global warming to temperature limit*(2)*					Variations in reductions in non-CO_2 emissions*(3)
		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 CO_2 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 CO_2 emissions from fossil fuels and cement production only – land use change is not included. 'Statitistical differences' (included in the GCP dataset) are not included here.

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

Greenhouse gas emissions

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

Damian Carrington
Environment editor
@dpcarrington

Mon 25 Oct 2021 10.00 BST

▲ 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.

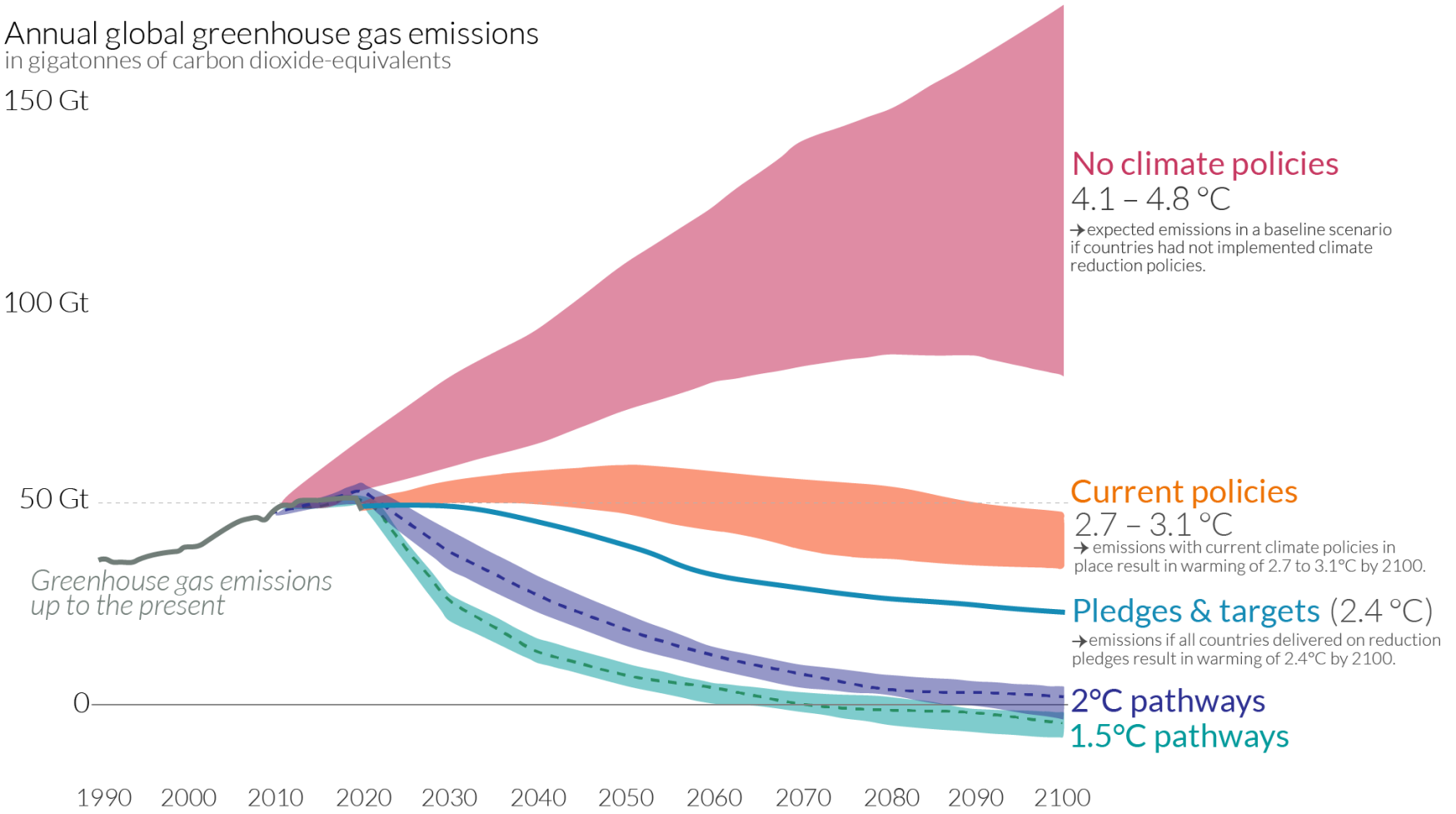
The concentration of carbon dioxide, the most important greenhouse gas, is now 50% higher than before the Industrial Revolution sparked the mass burning of fossil fuels. Methane levels have more than doubled since 1750. All key greenhouse gases (GHG) rose faster in 2020 than the average for the previous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

The Guardian – 25th October 2021

Global greenhouse gas emissions and warming scenarios

Our World in Data

– 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.



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.

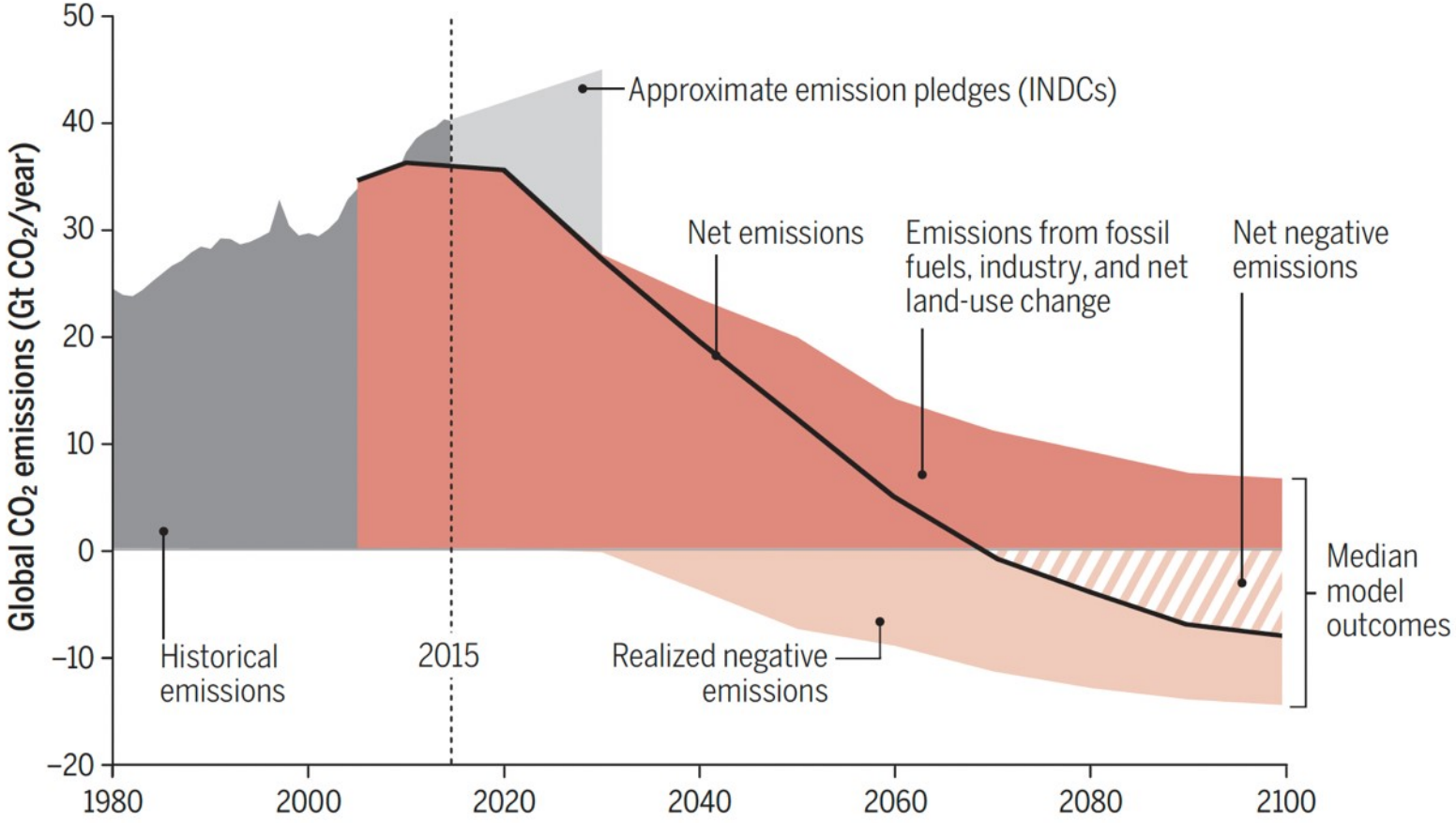
Last updated: July 2021.

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

2021 UNEP Emissions Gap Report

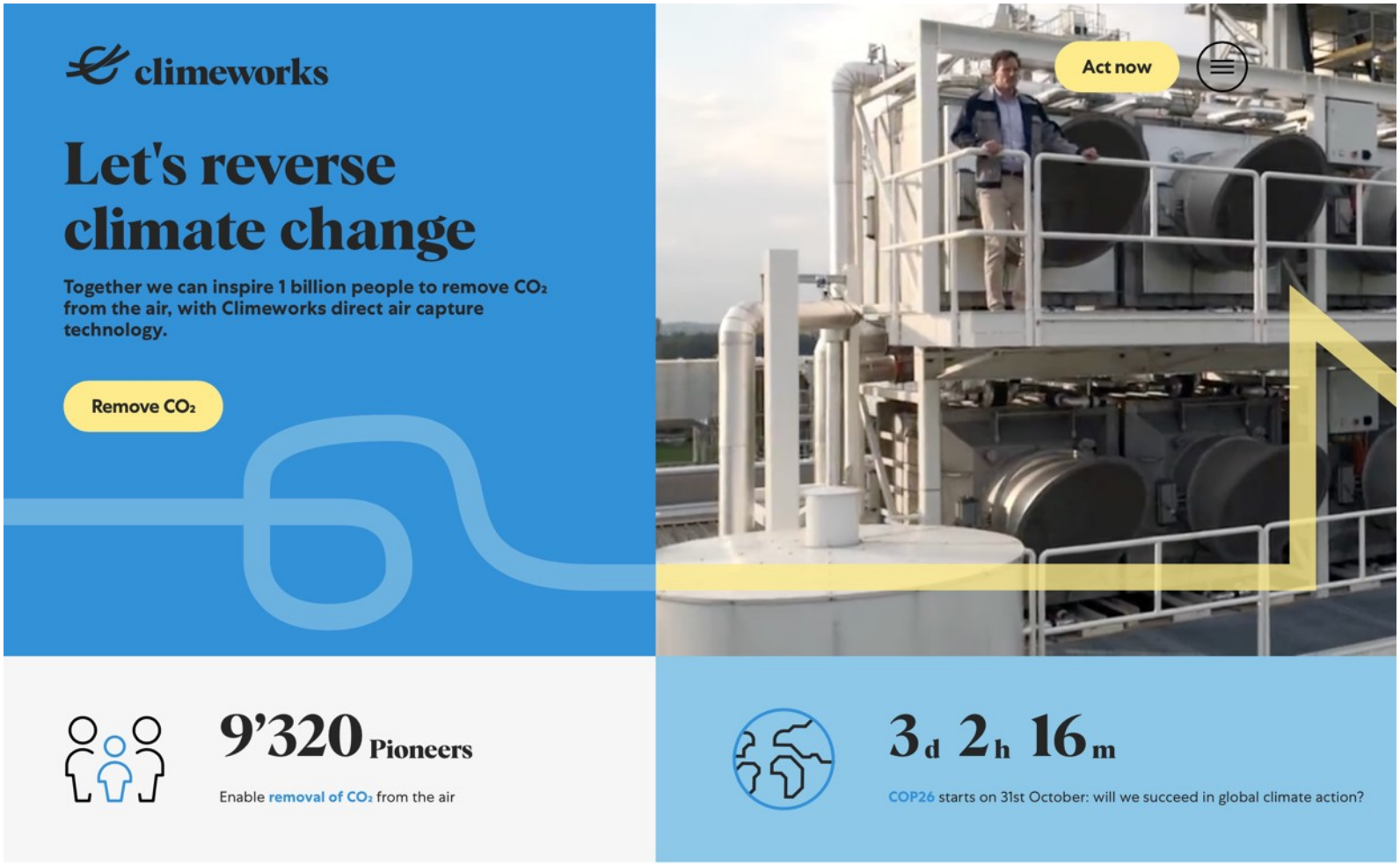
- New and updated NDCs only reduce 2030 emissions by 7.5% when reduction of 55% is required to meet the 1.5°C Paris ambition.
- Current climate pledges for 2030 currently put the world on track for a warming of 2.7°C by the end of the century.
- Net zero pledges currently submitted for COP26 would only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



Join the journey towards a climate-positive world

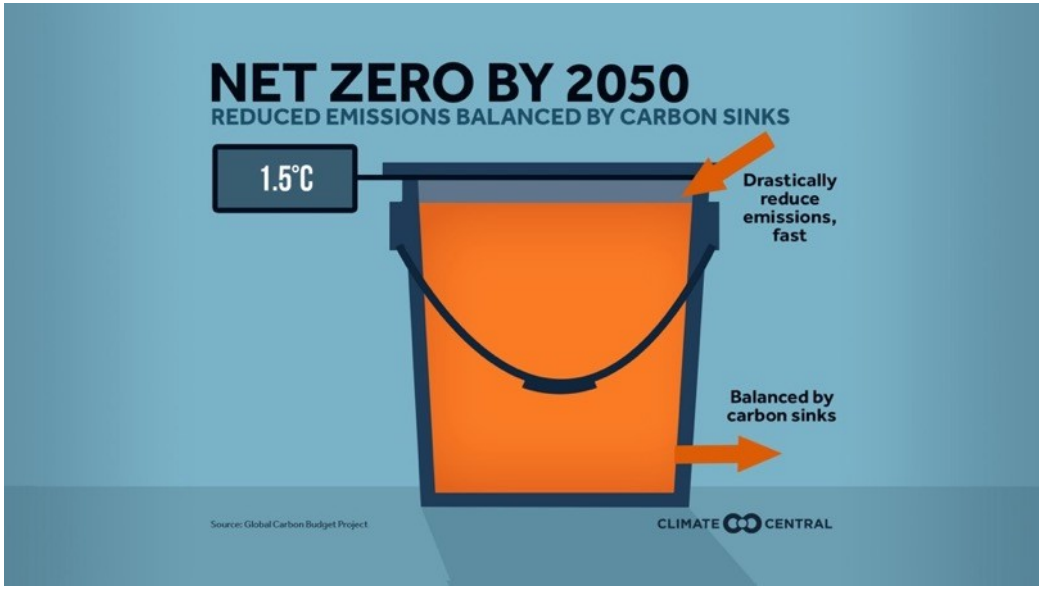
A climate-positive world requires us to reduce, reuse, recycle... then remove. We can remove unavoidable and historic CO_2 from the air in a safe and permanent way. Each and every one of us can make a huge impact and when we all do it together, we can change the world. #Actnow and stay up to date in 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)

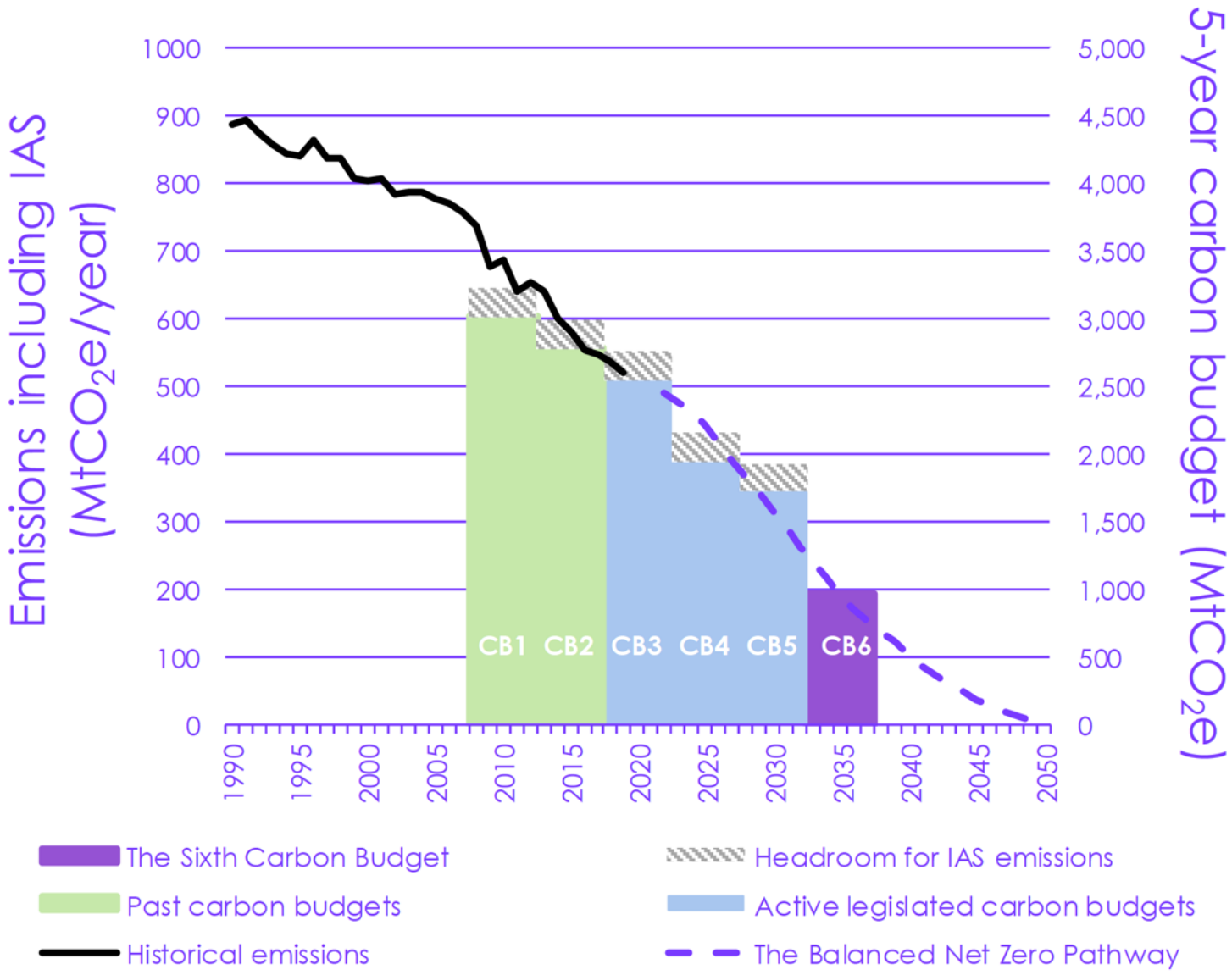
4. What can we do about it?

"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.

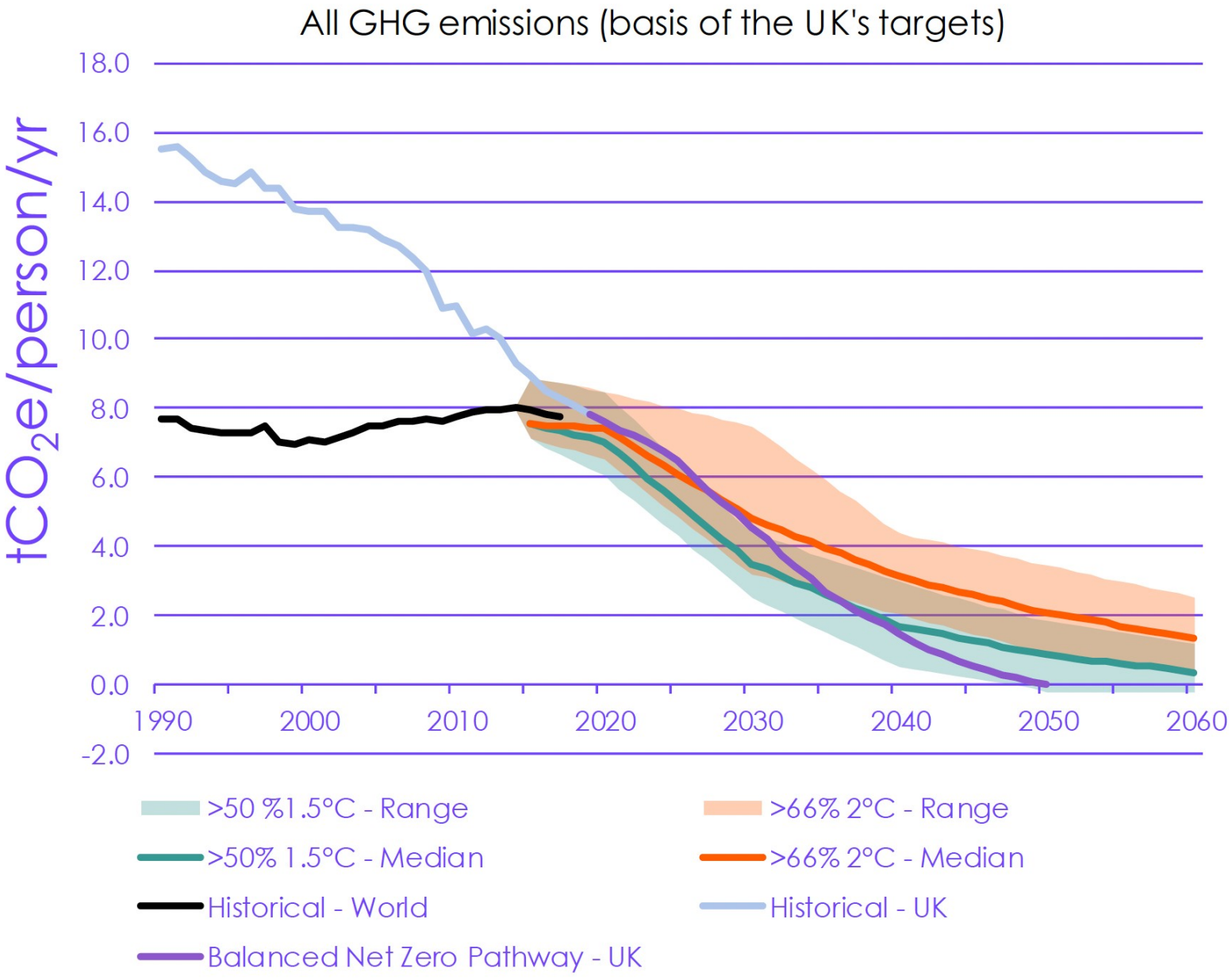
We have to stop our emissions of greenhouse gases."

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/



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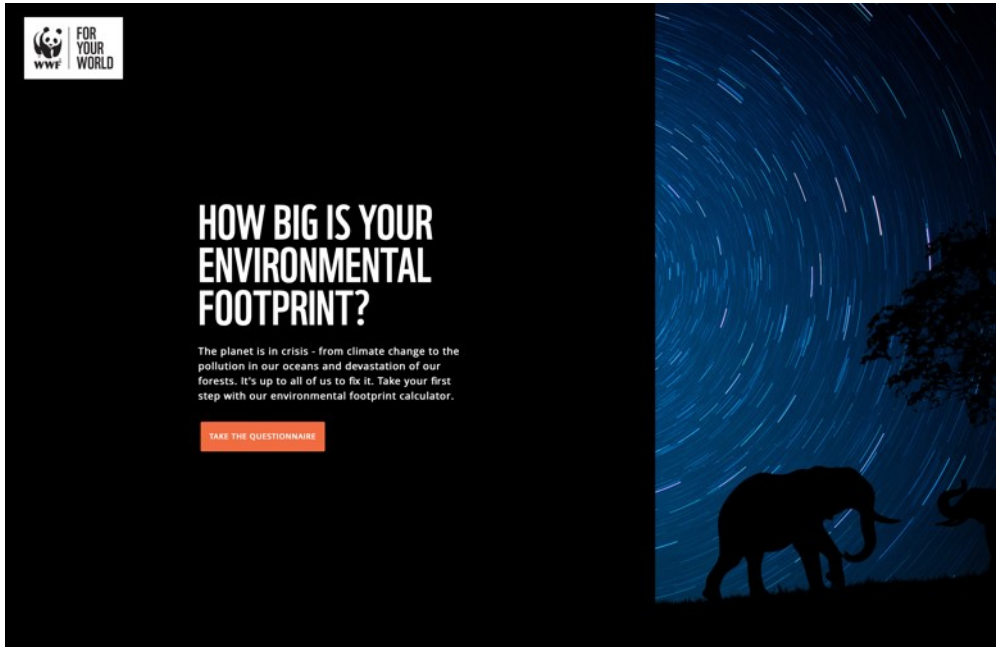

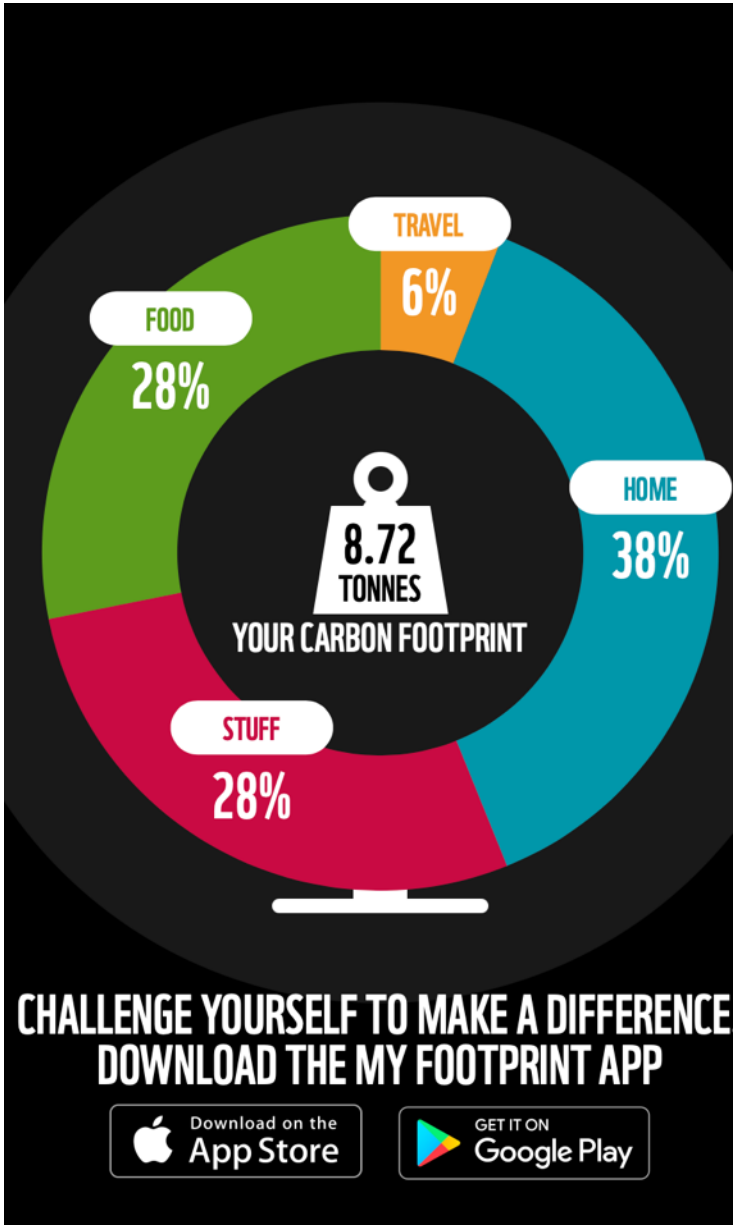

Step 1: Take and active interest in your carbon footprint

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

IOP Publishing Environ. Res. Lett. 15 (2020) 093001 https://doi.org/10.1088/1748-9326/ab8589

Environmental Research Letters

TOPICAL REVIEW

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

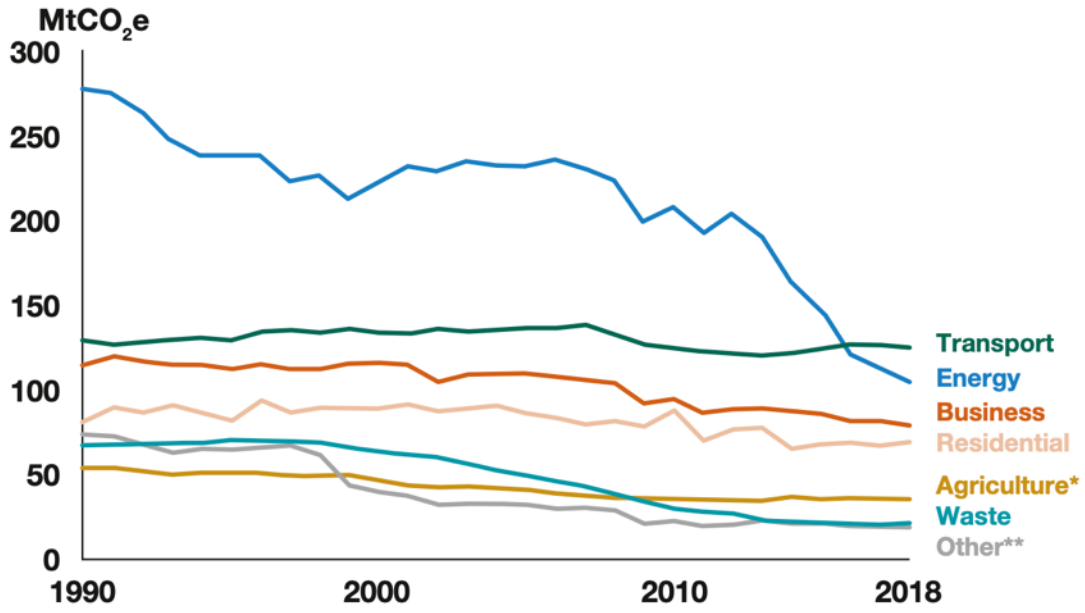
Supplementary material for this article is available online

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

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

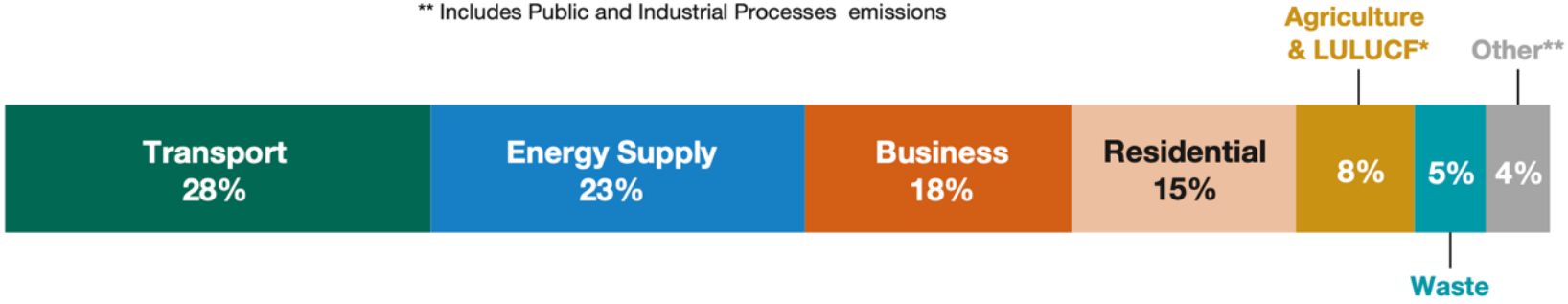

1. Energy



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

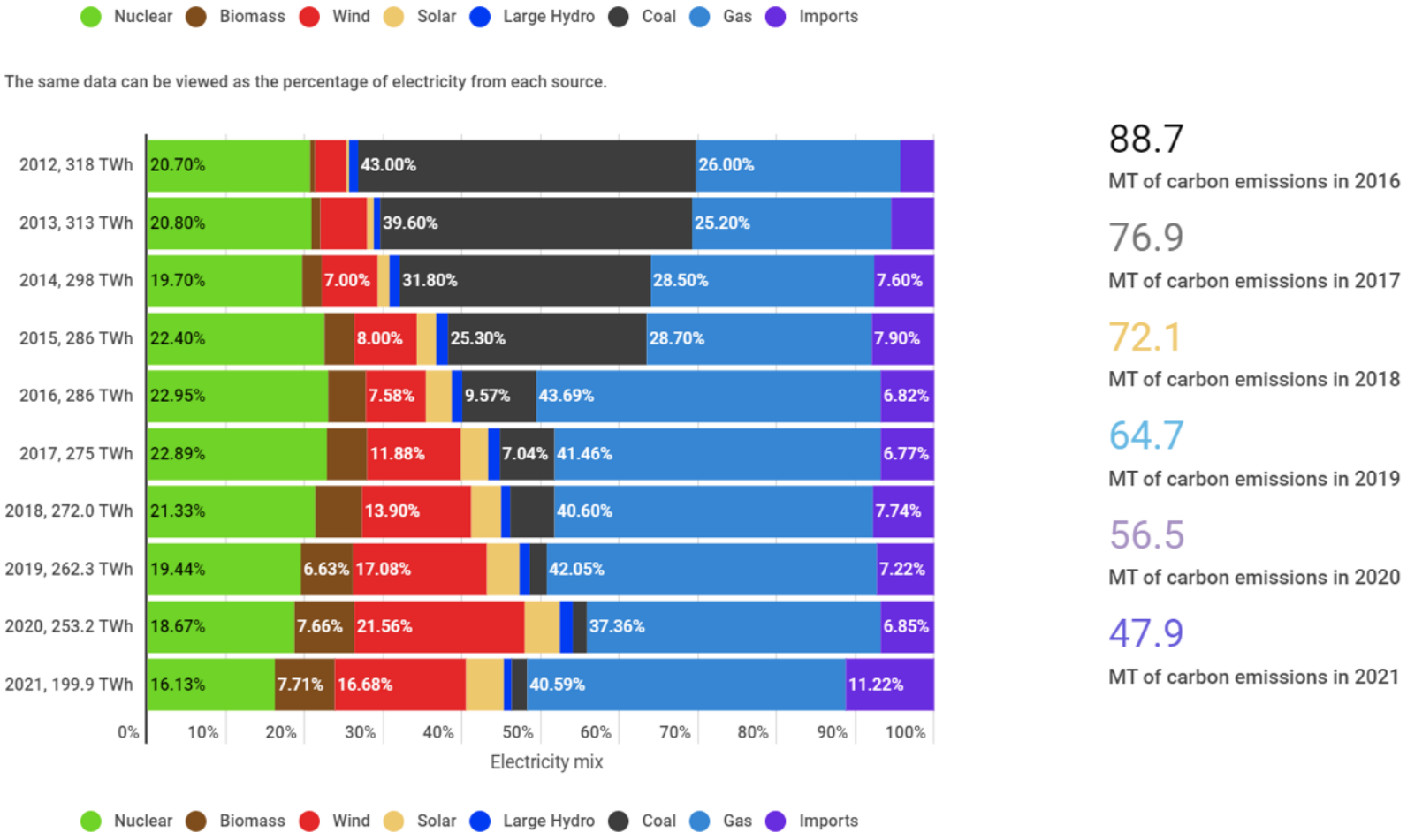
Transport became the largest emitting sector of GHG emissions in 2016
This follows large decreases in energy emissions while transport emissions have remained relatively static.

451 million tonnes of CO_2 equivalent ($MtCO_2e$)
is the total net domestic greenhouse gas emissions from all UK sectors in 2018, down 2.1% from 2017.



Source: 2018 UK greenhouse gas emissions[10]

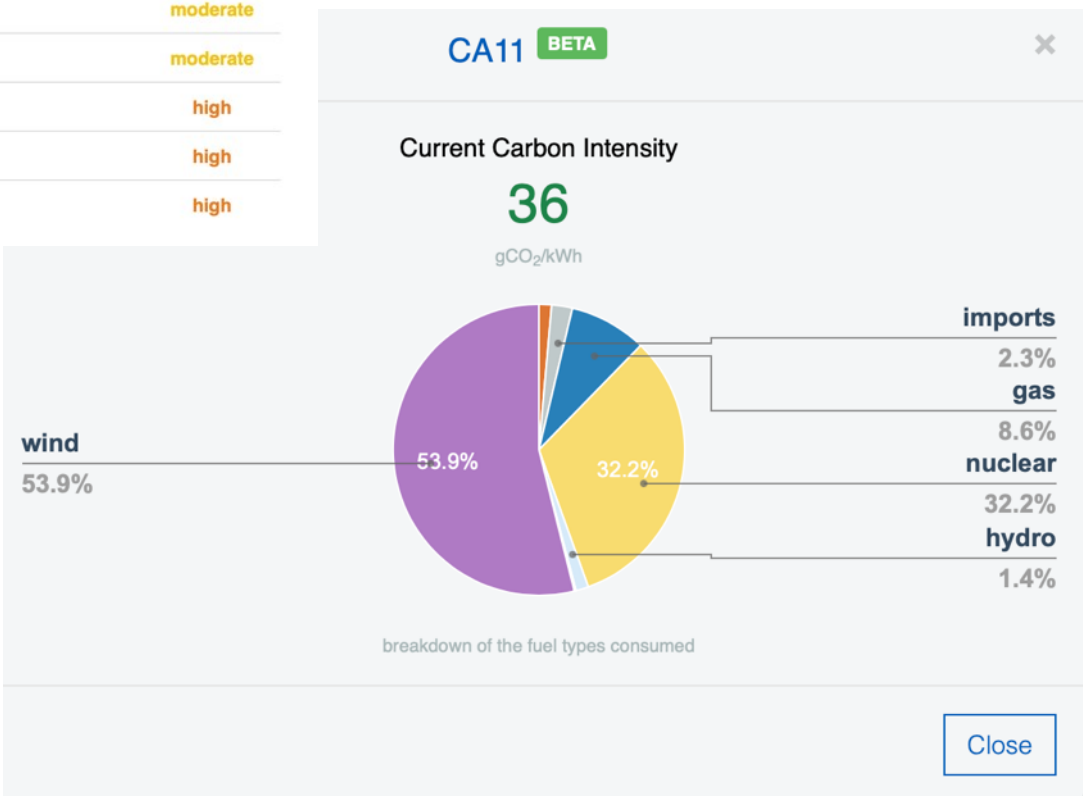
DfT (2020) – Decarbonising Transport: Setting the Challenge (p11)
https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/932122/decarbonising-transport-setting-the-challenge.pdf



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



https://carbonintensity.org.uk

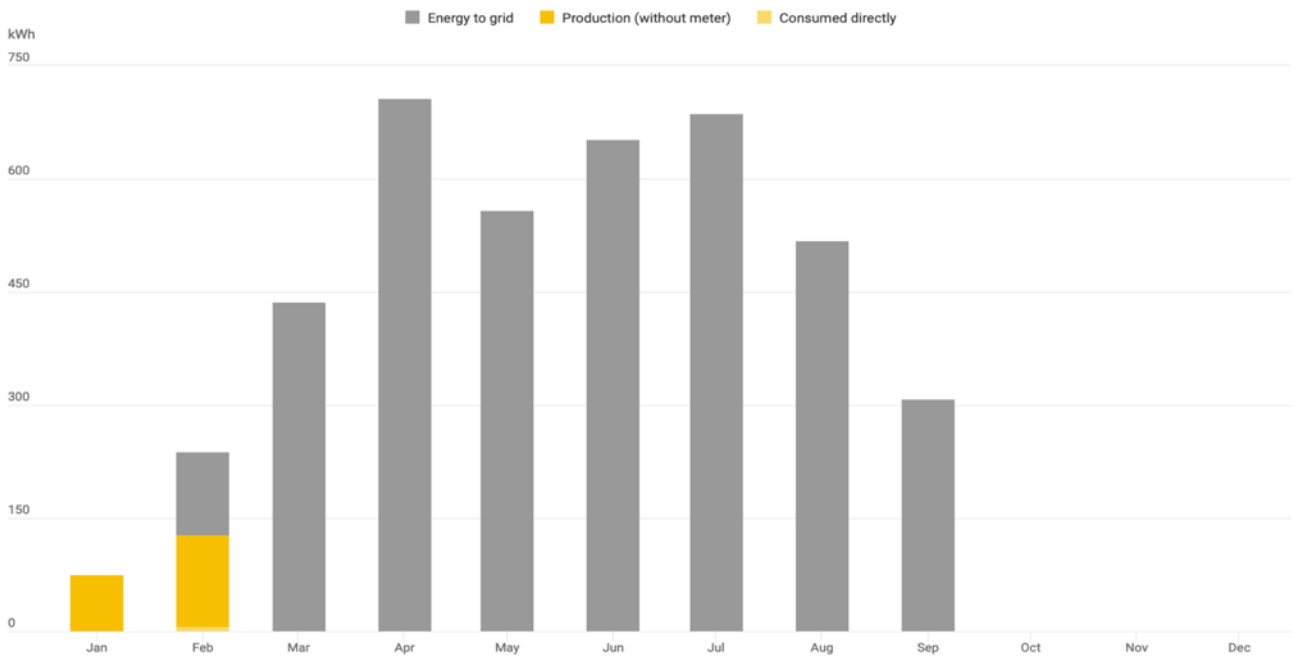
“Grow your own”

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 CO_2 assuming grid carbon intensity of 181g CO_2/kWh

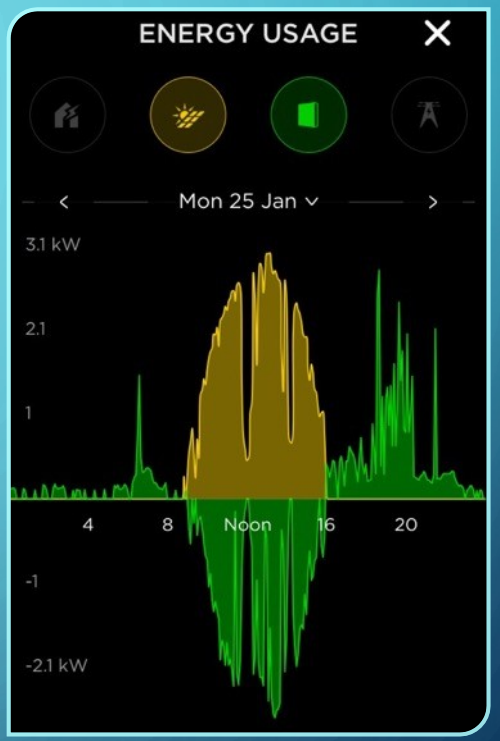


Month	Jan	Feb	March	April	May	June	July	Aug
Total	76	239	437	708	545	653	687	518
Average	4.5	8.5	14.1	23.6	17.6	21.8	22.2	16.7
Max	13.0	20.4	25.2	33.7	35.6	33.2	34.0	29.2
Min	0.3	1.2	2.0	8.2	4.1	6.3	7.3	6.9

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

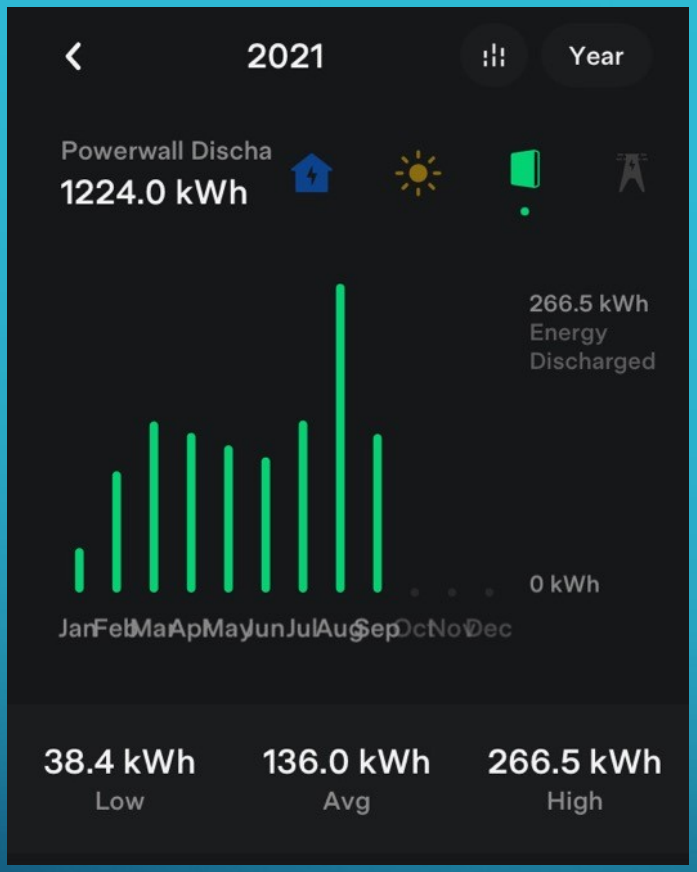
https://communityenergyengland.org

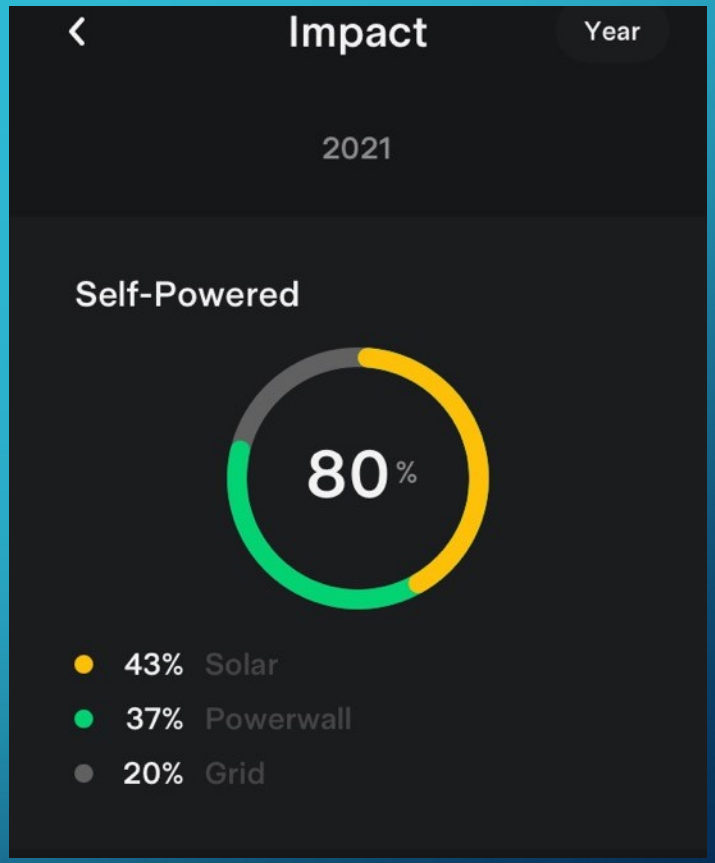
Domestic Energy Storage (Tesla Powerwall 2)



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

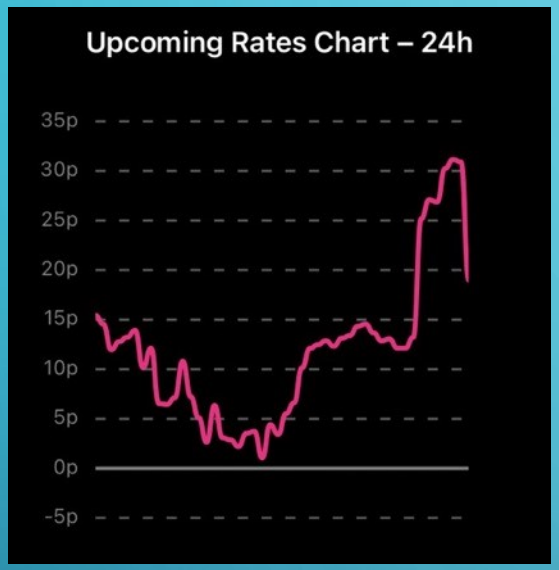
- Store surplus energy during the day to use overnight.
- To stay “off grid” during cloudy days.
- Greater self-sufficiency.

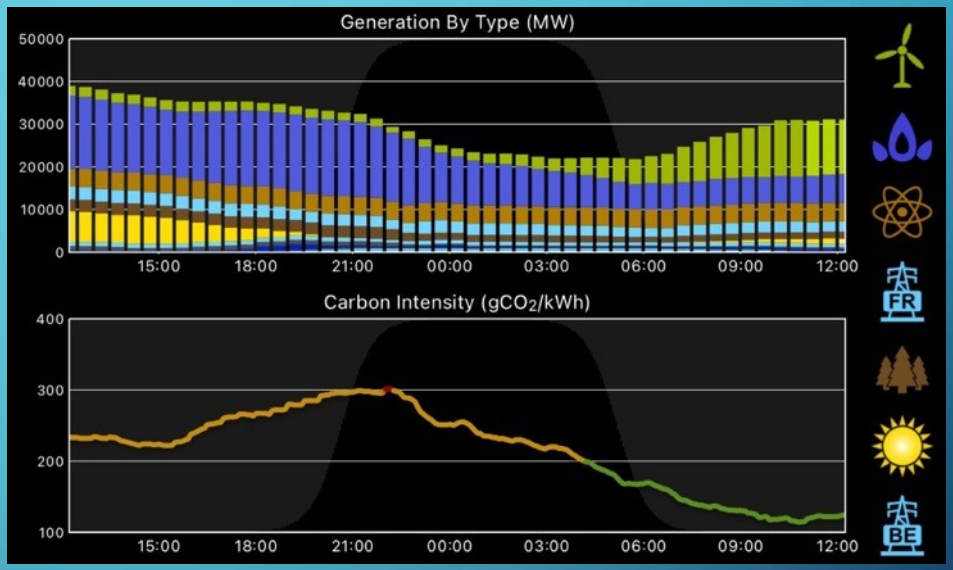




37% of the household consumption has come from the battery largely in the form of stored solar energy – allowed us to be 80% “self-powered” so far…

Taking advantage of “time of use tariffs”

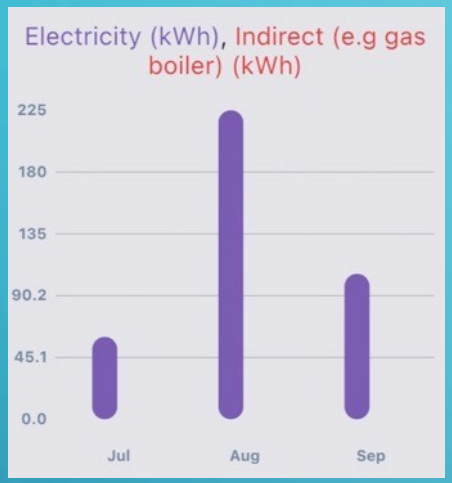


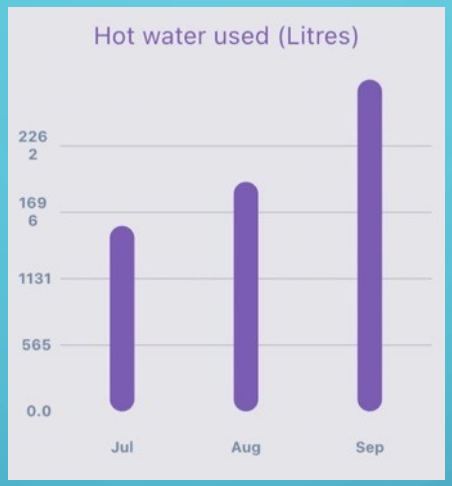


Can use a domestic battery to take advantage of “time of use” tariffs:

- 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



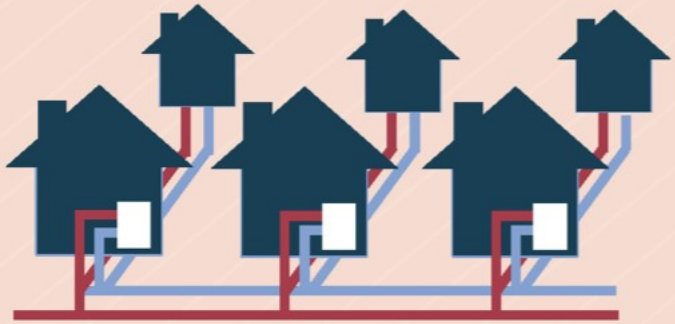


Installed 23rd July

- 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.

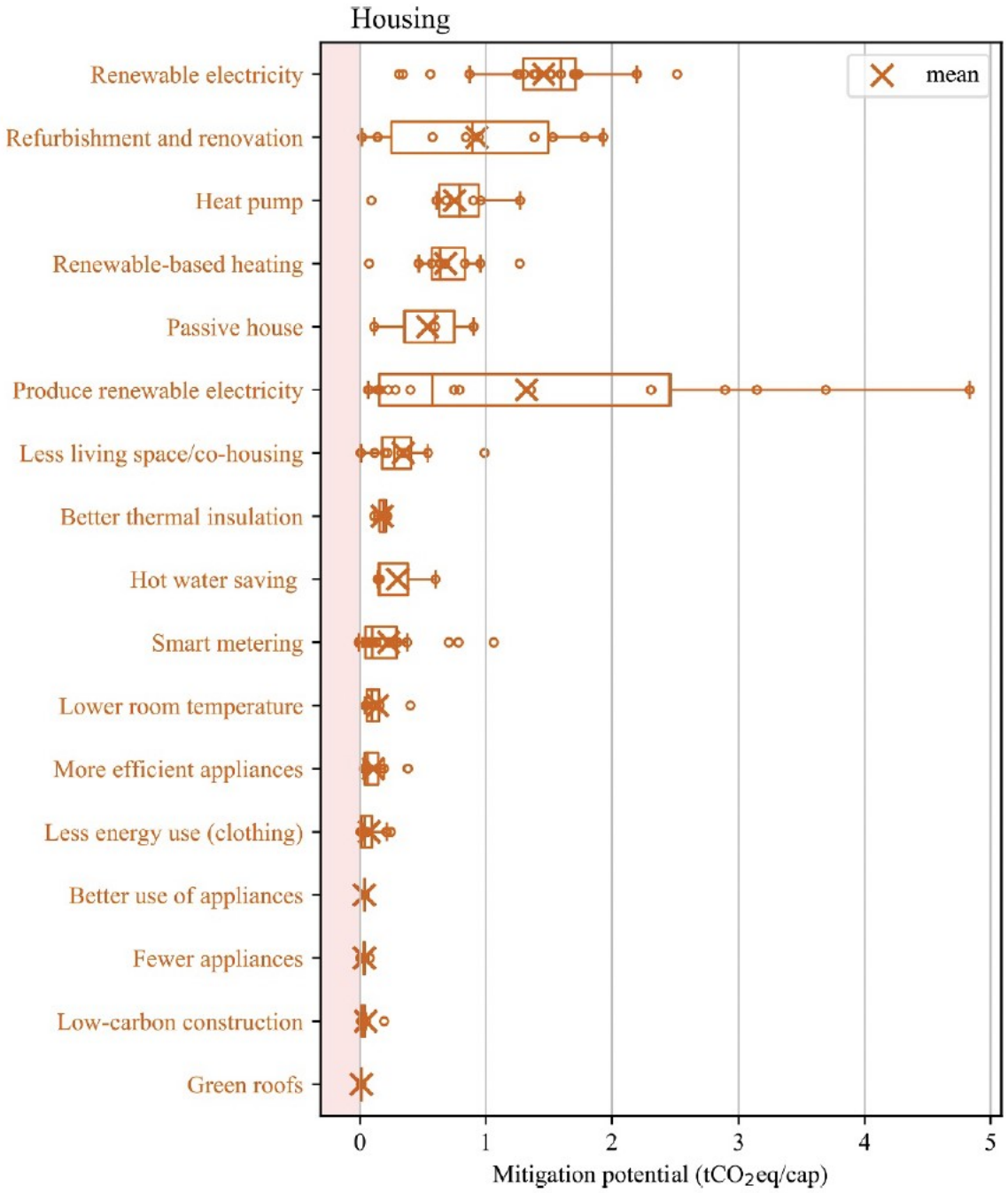
Heating

1 in 20 homes with a gas boiler could join a heat network, saving **2 tonnes of CO_2 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 CO_2 per year** and **0.8 tonnes of CO_2 per year** respectively.

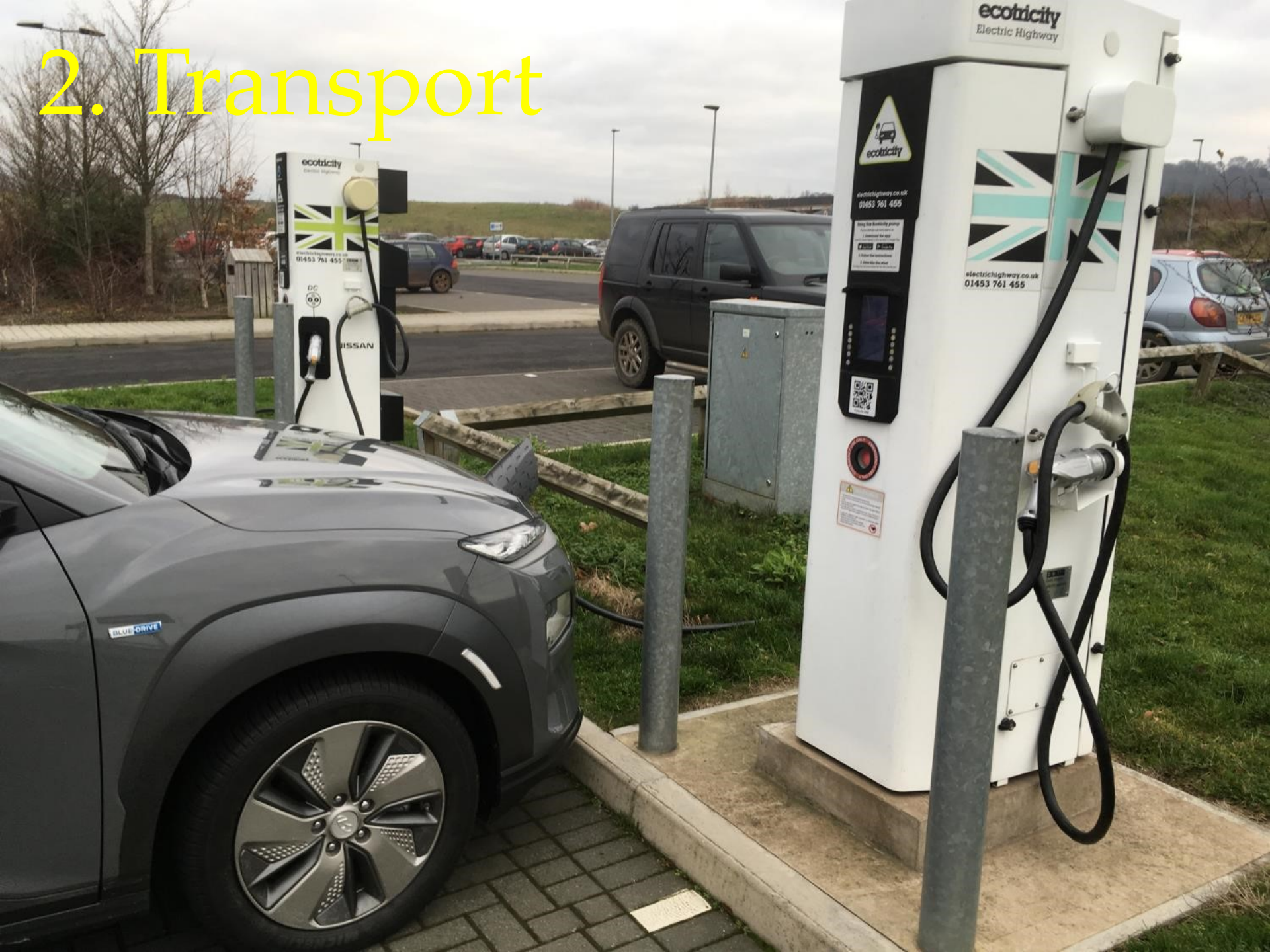
https://www.theccc.org.uk/2016/07/20/fifth-carbon-budget-infographic/



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.

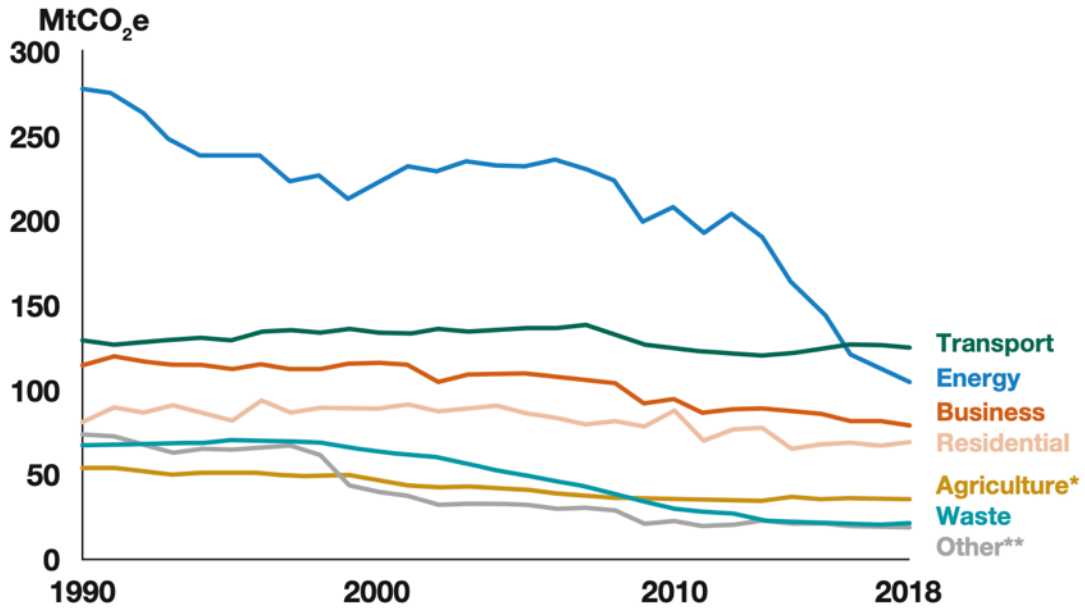
2. Transport


ecotricity
Electric Highway
electrichighway.co.uk
01453 761 455
NISSAN
BLUE DRIVE

Transport & Carbon

- Transport sector is responsible for the release of 8 Gt/yr of CO_2 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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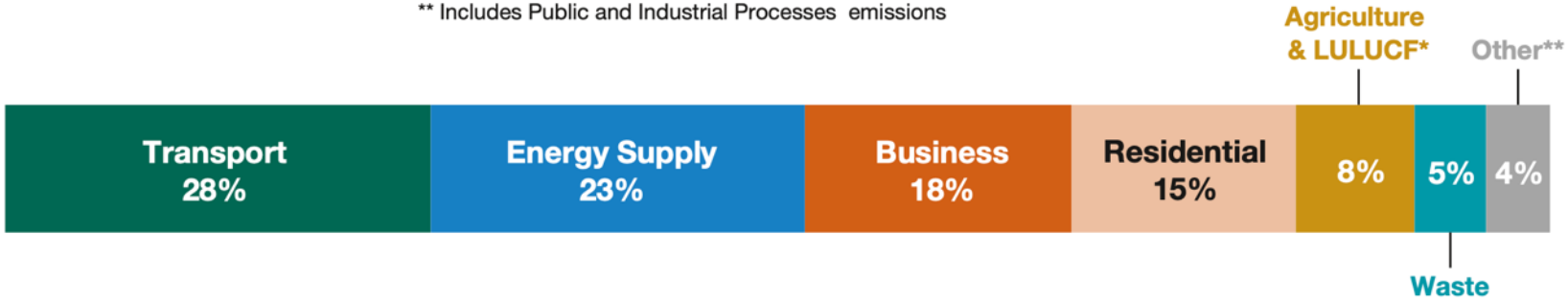

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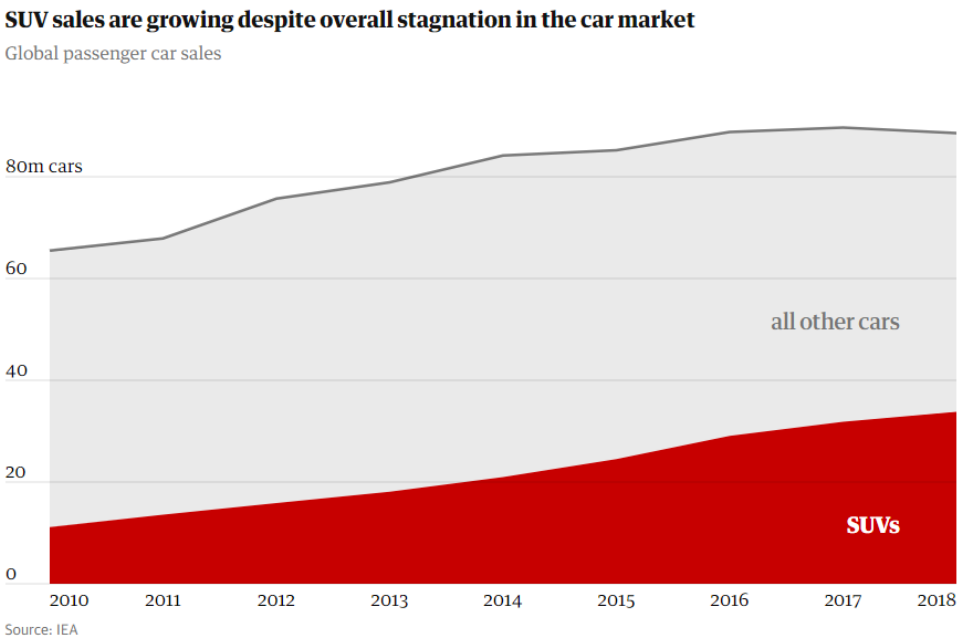
DfT (2020) – Decarbonising Transport: Setting the Challenge (p11)
https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/932122/decarbonising-transport-setting-the-challenge.pdf

Carbon footprint of travel

London to Glasgow (return) – 411 miles

- 30kg CO_2e bike
- 40kg CO_2e coach
- 64kg CO_2e train
- 148kg CO_2e small BEV (driver only)
- 237kg CO_2e small efficient ICE car (driver only)
- 368kg CO_2e plane
- 1002kg CO_2e 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.



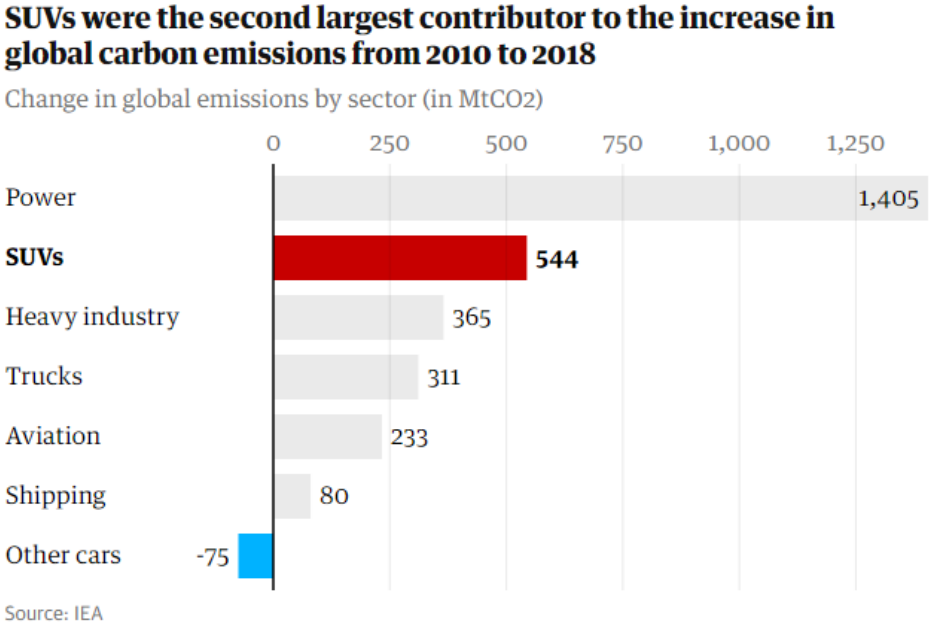
Car manufacturers driving demand in the wrong direction in the promotion of SUVs ("Sports Utility Vehicles)?

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



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…

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 = 2778x0.165 = £471
Work = 2778x0 = £0

Total cost = £458.37

Servicing and maintenance costs are also generally much cheaper.
+ Zero road tax.

EV Smart Charging – MyEnergi Zappi

- 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

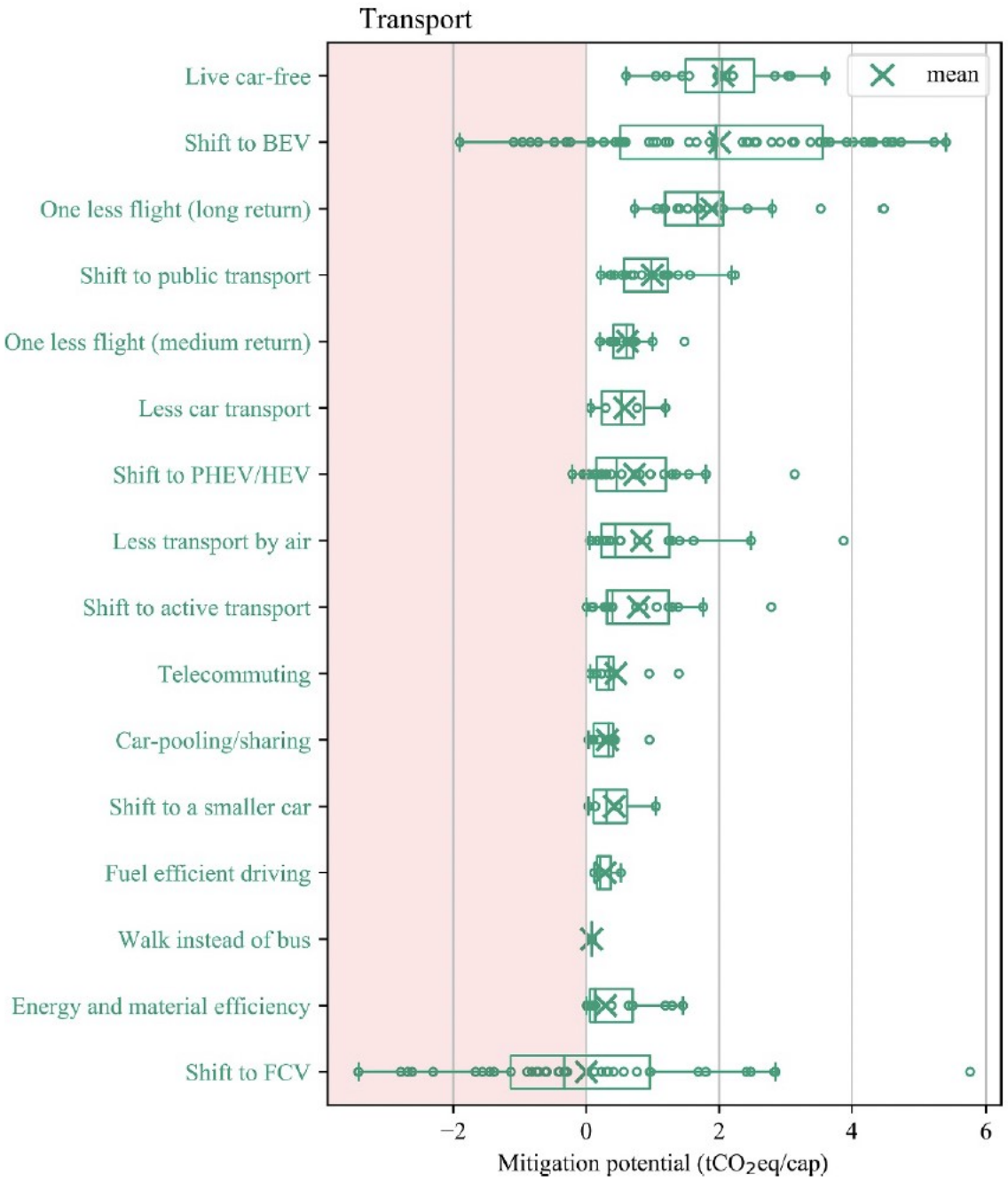
Carbon, Land and Water Footprint per km and per Capita Year^{-1} of Driving a Car Fuelled by Conventional Gasoline, Biodiesel Blend B20, Bio-Ethanol Blend E85, Bio-Electricity, Solar Electricity or Solar-Based Hydrogen

		Biofuel blend		Electricity		Hydrogen
	Gasoline	B20[1,a]	E85[2,a]	Bio[3,a]	Solar (PV)[c]	
Carbon footprint (g CO_2eq/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_2eq/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"

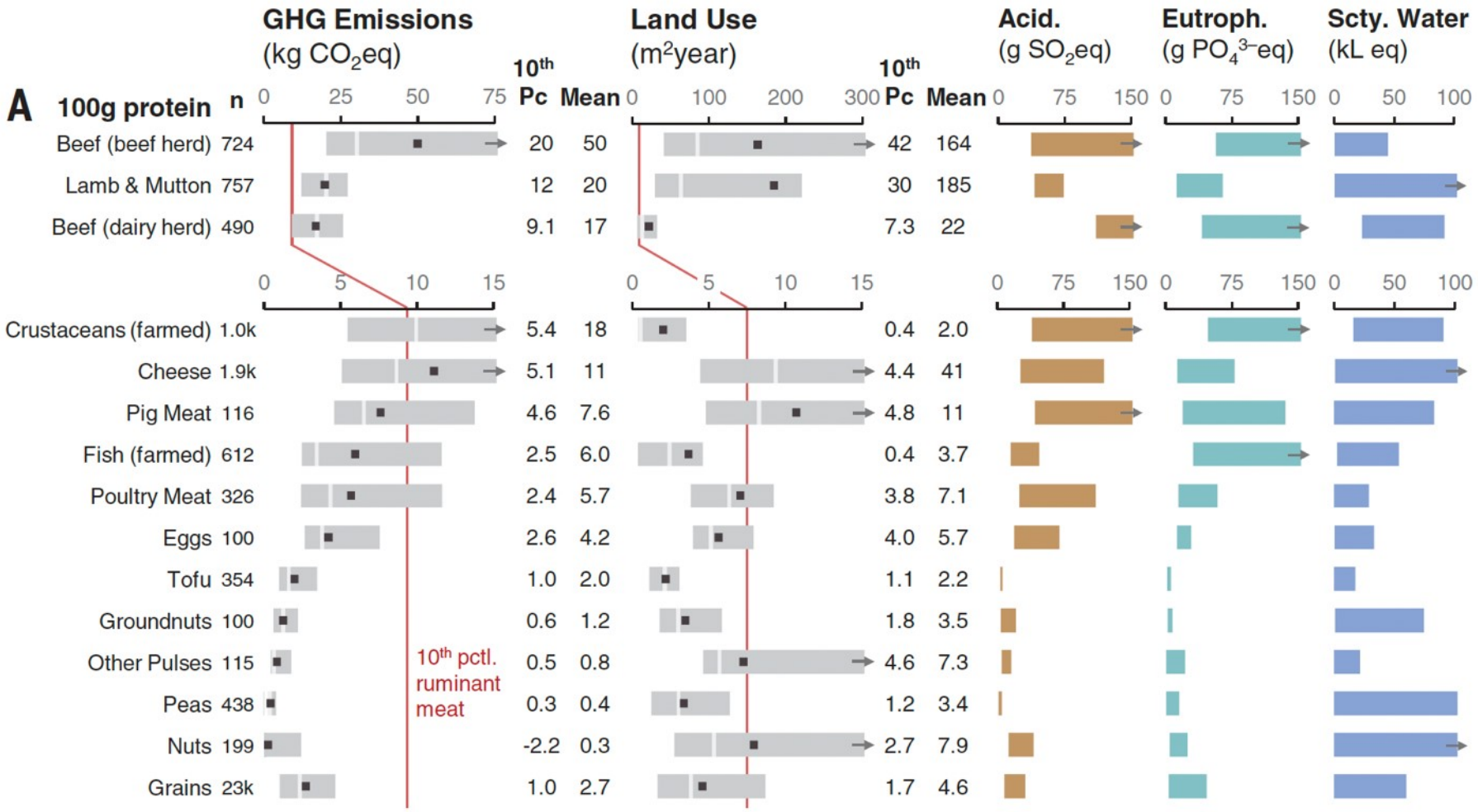
Holmatov, R. & Hoekstra, A.Y., 2020. The environmental footprint of transport by car using renewable energy. *Earth's Future*, 8, e2019EF001428.



Quick wins

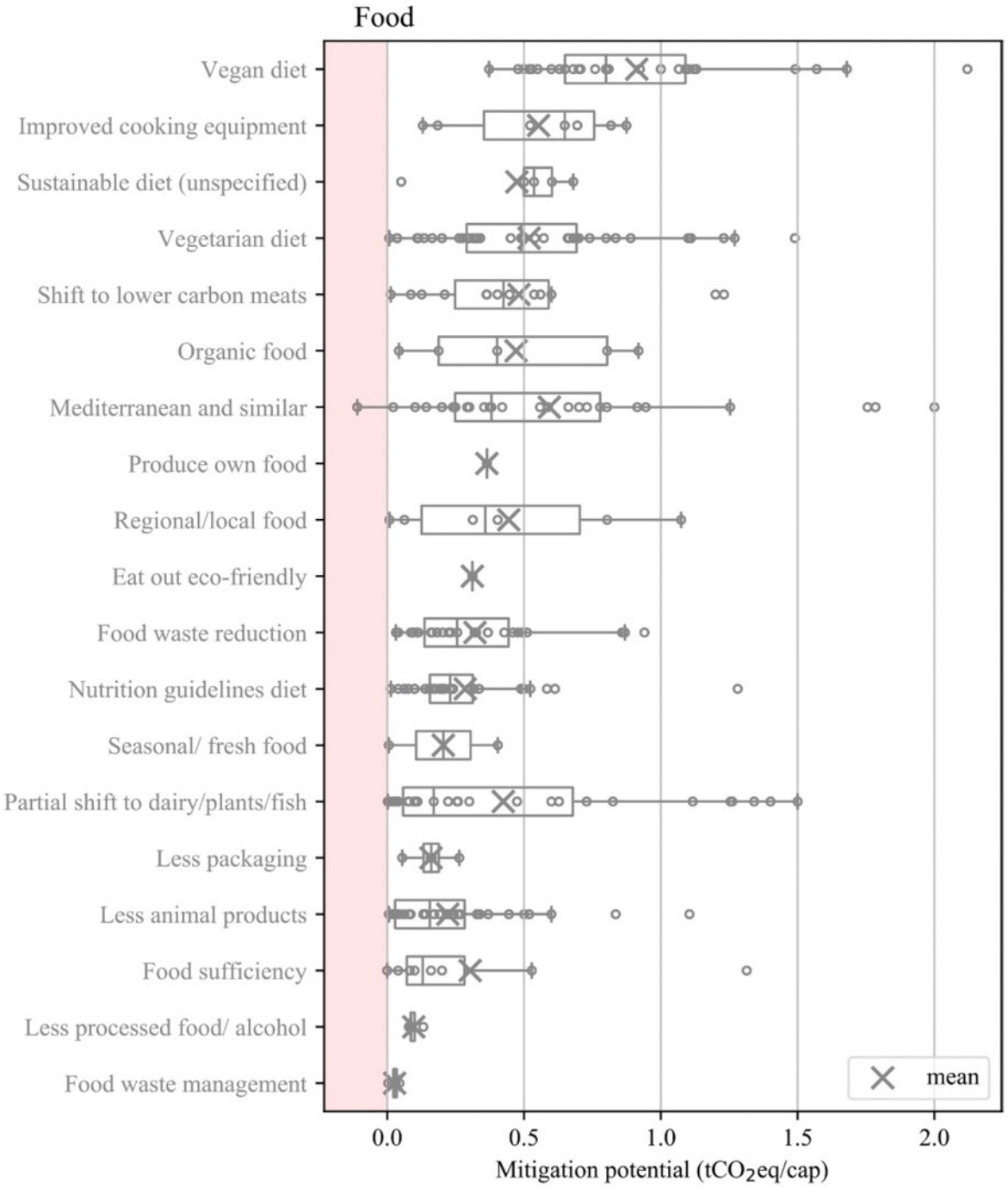
- Rely more on active travel for short journeys.
- Use public transport when possible.
- Think twice about flying.
- Opportunity to hold meetings online?

3. Food



Environmental footprints of protein-based foods.

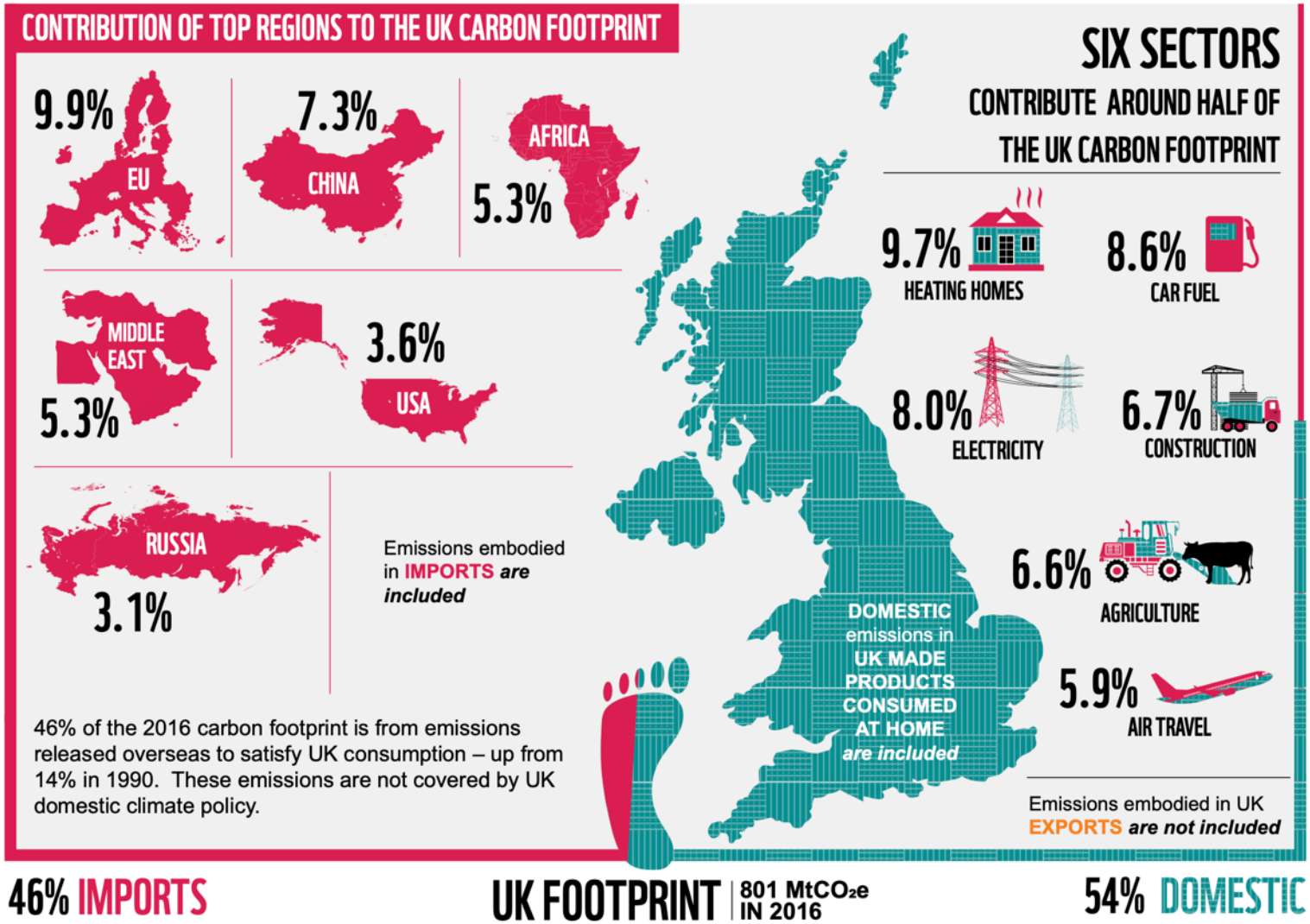
Poore, J. & Nemecek, T., 2018. Reducing food's environmental impacts through producers and consumers. *Science*, *360*(6392), pp.987-992.



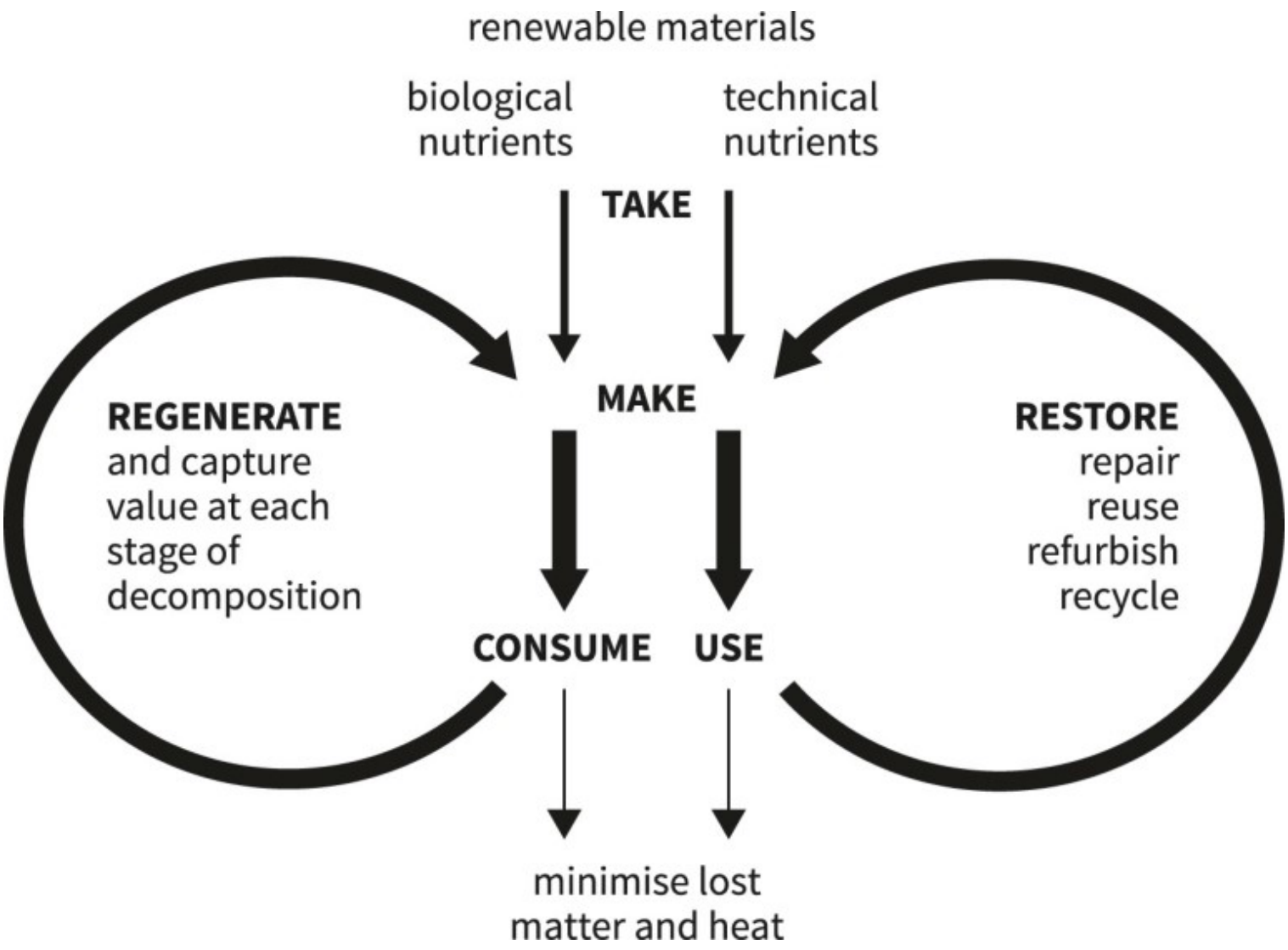
Quick wins

- 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://ideas.ted.com/why-we-need-to-move-toward-an-economy-that-can-regenerate-itself/

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?


Eden
Wild
Goose