

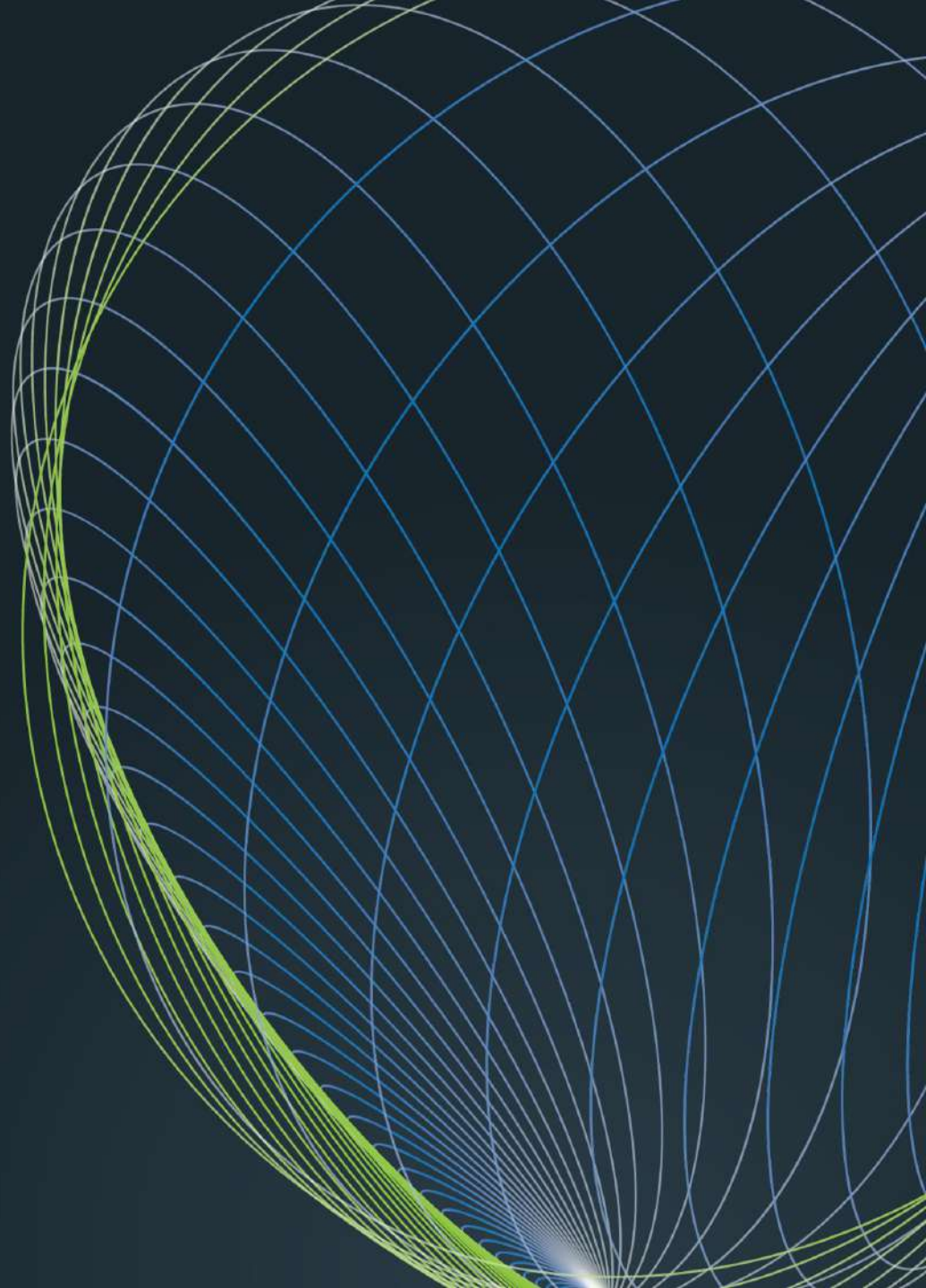


Systems thinking and tipping points for planetary health

Tim Lenton

Director, Global Systems Institute, University of Exeter
t.m.lenton@exeter.ac.uk

exeter.ac.uk/gsi

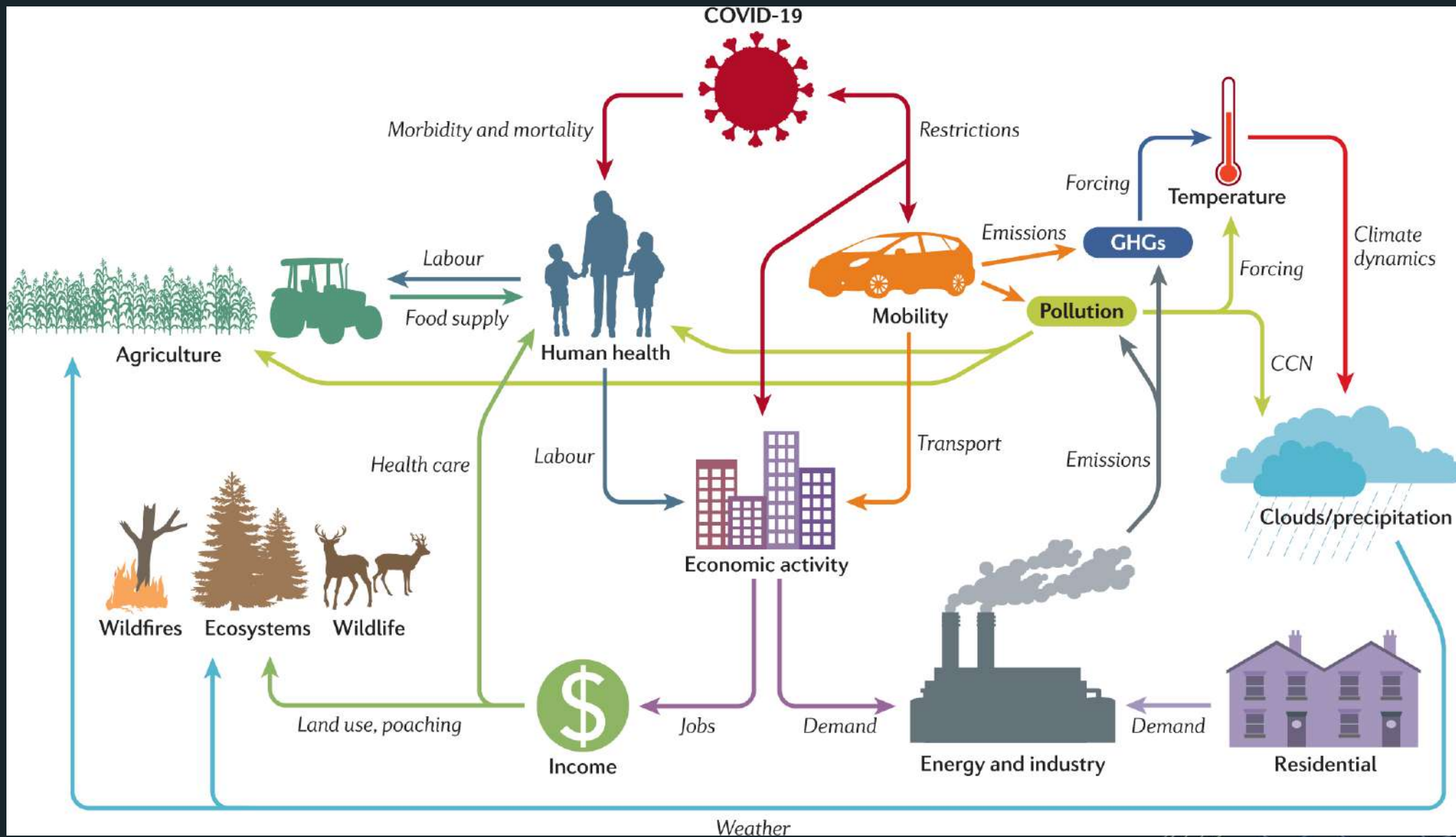


A satellite view of Earth at night, showing the illuminated continents of Europe and Africa. The image is overlaid with a network of thin, glowing lines representing global communication or data networks. The text "WELCOME TO THE ANTHROPOCENE" is prominently displayed in the center.

WELCOME TO THE ANTHROPOCENE

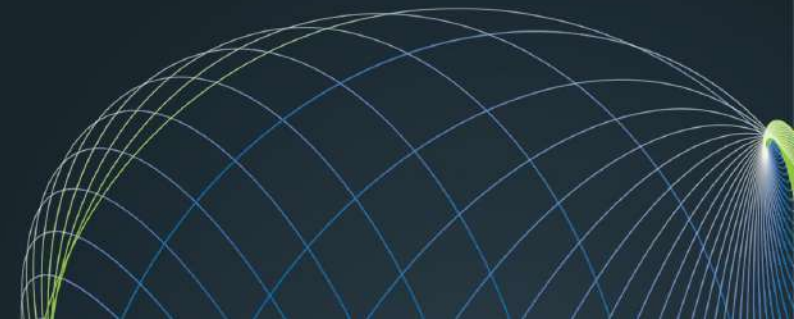
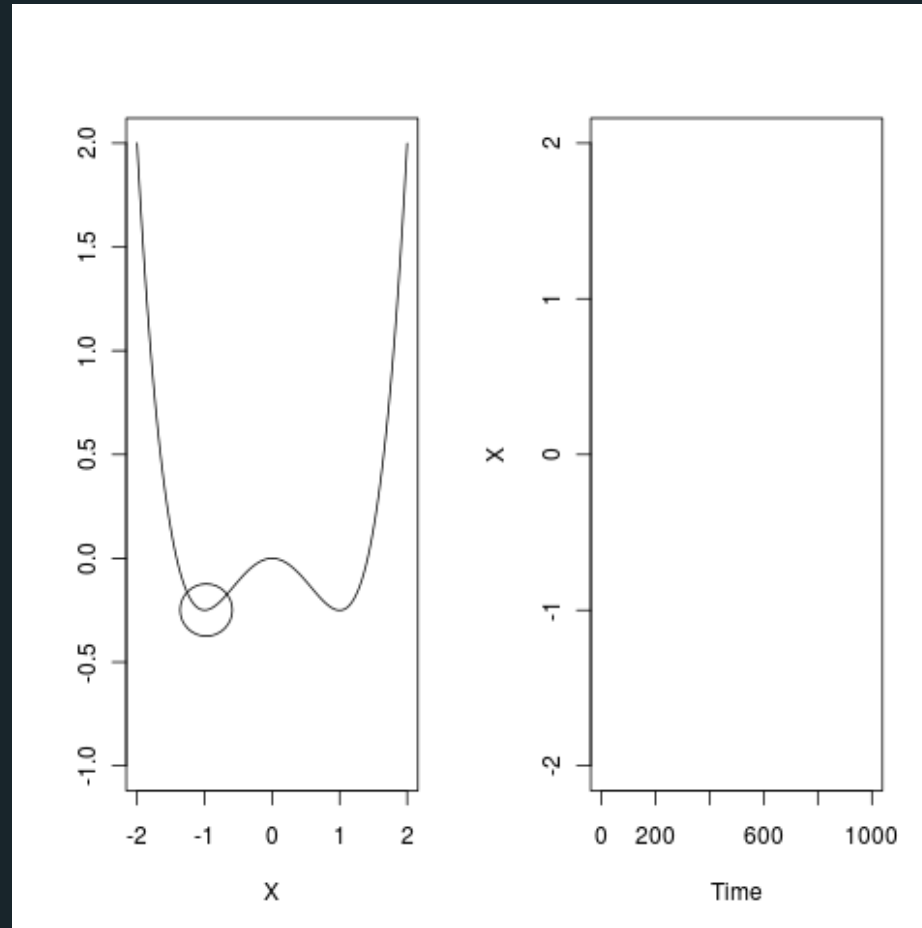
Global Systems Institute

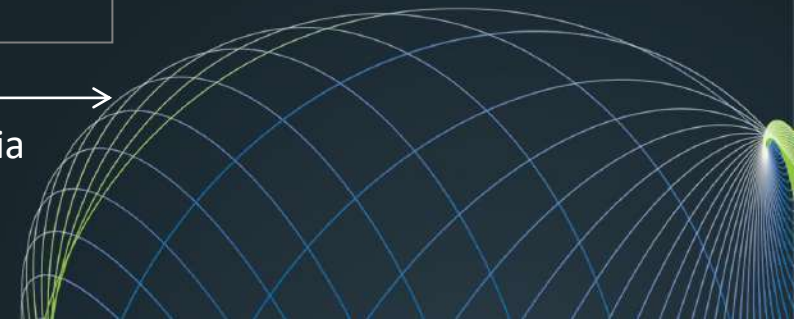
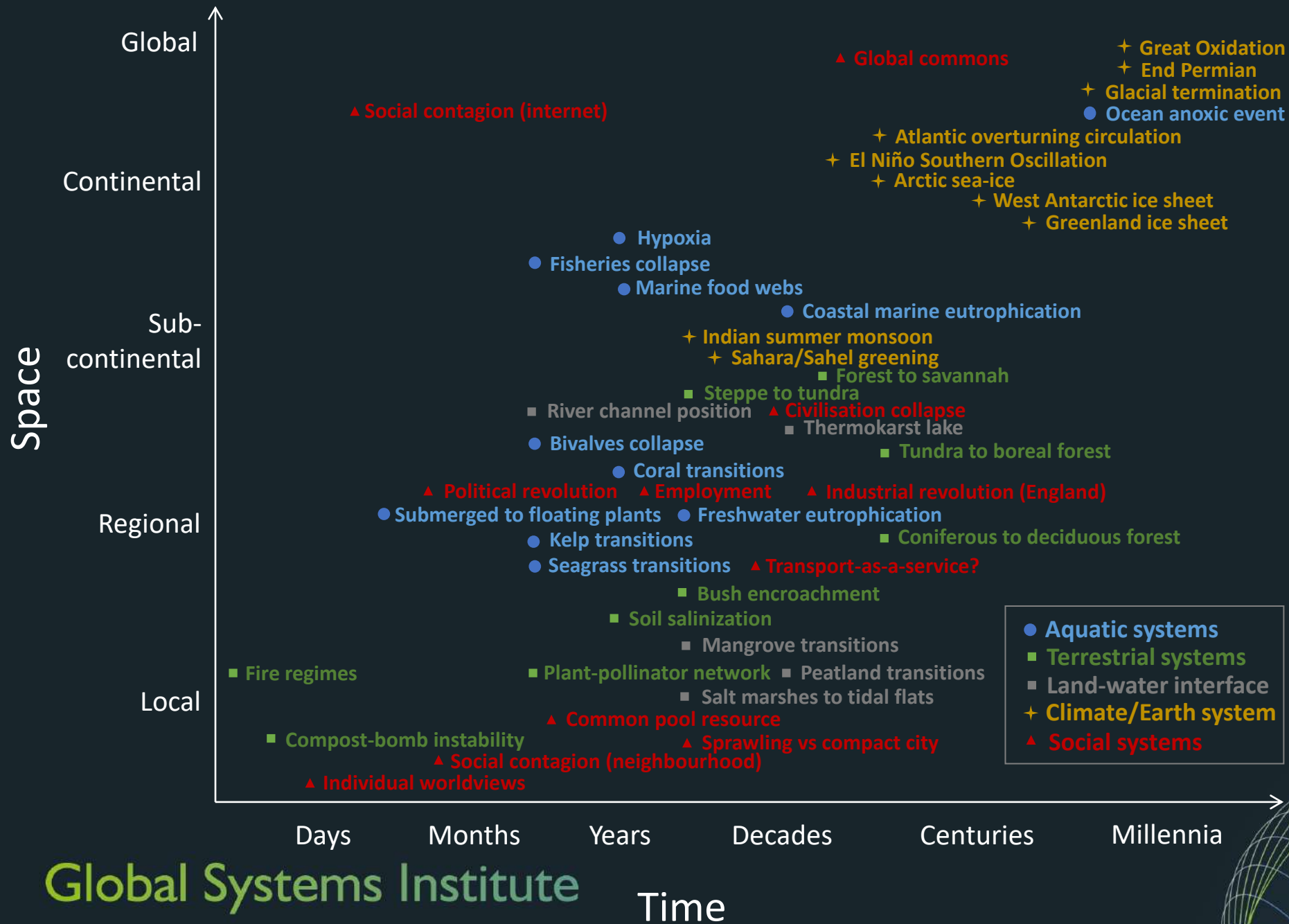




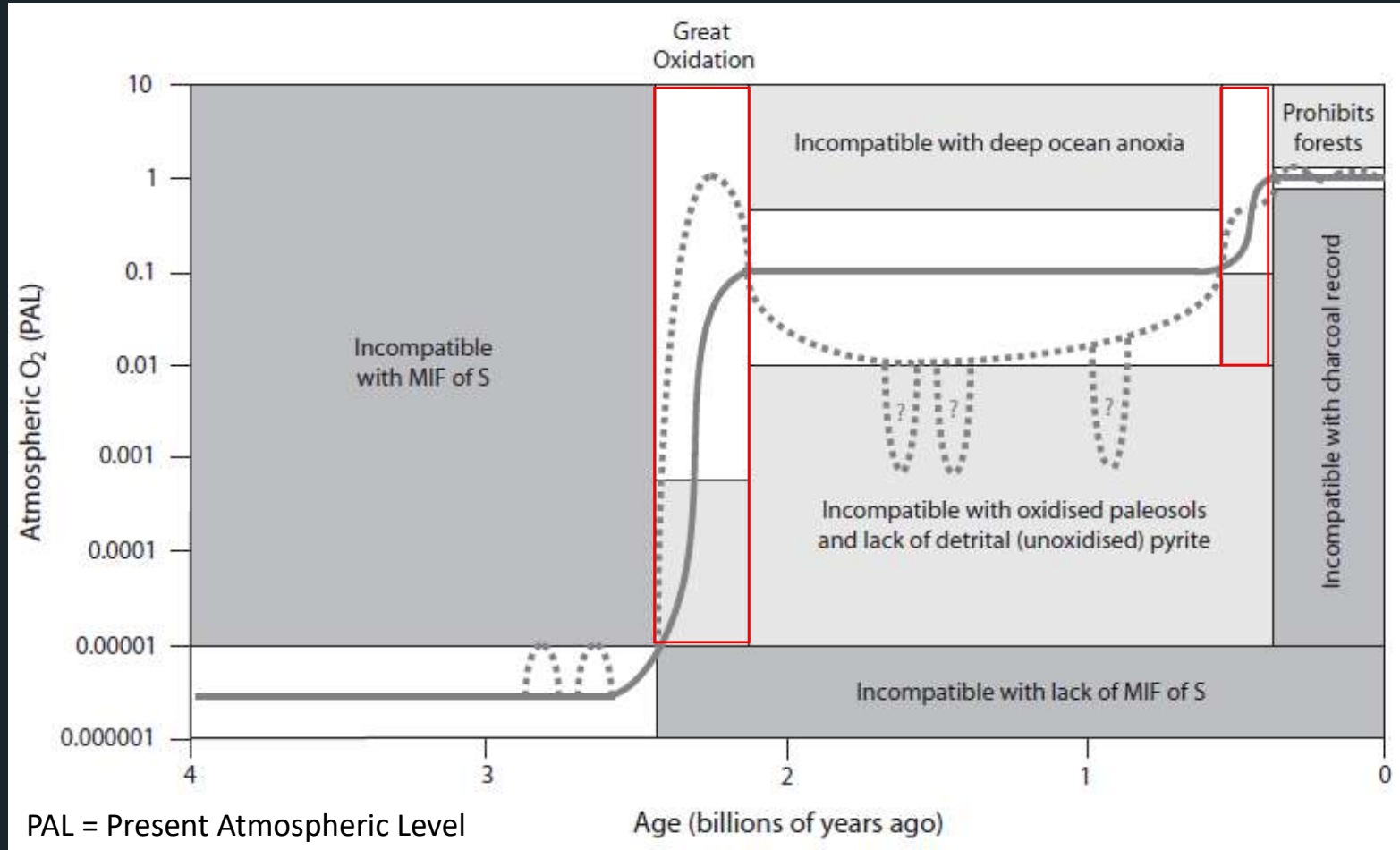
Diffenbaugh et al. (2020) 'The COVID-19 lockdowns: a window into the Earth system' *Nature Reviews Earth & Environment*

Generic example of passing a tipping point

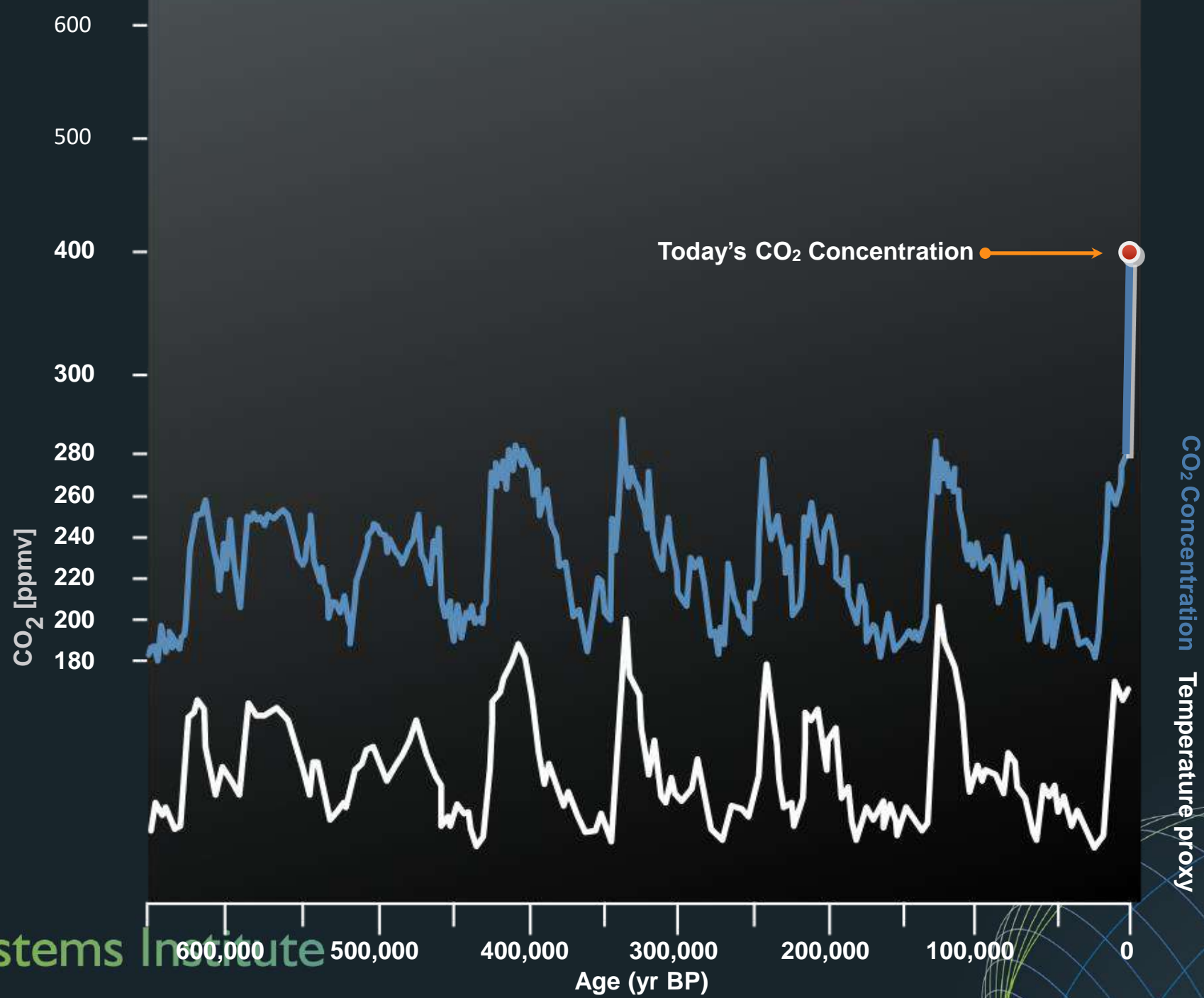


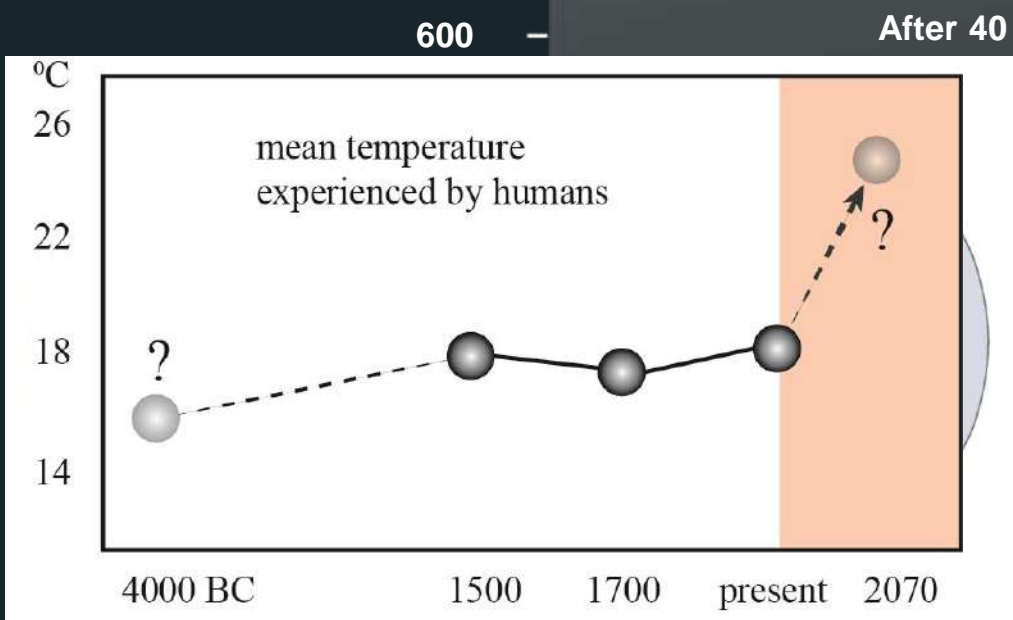


Tipping points in Earth history



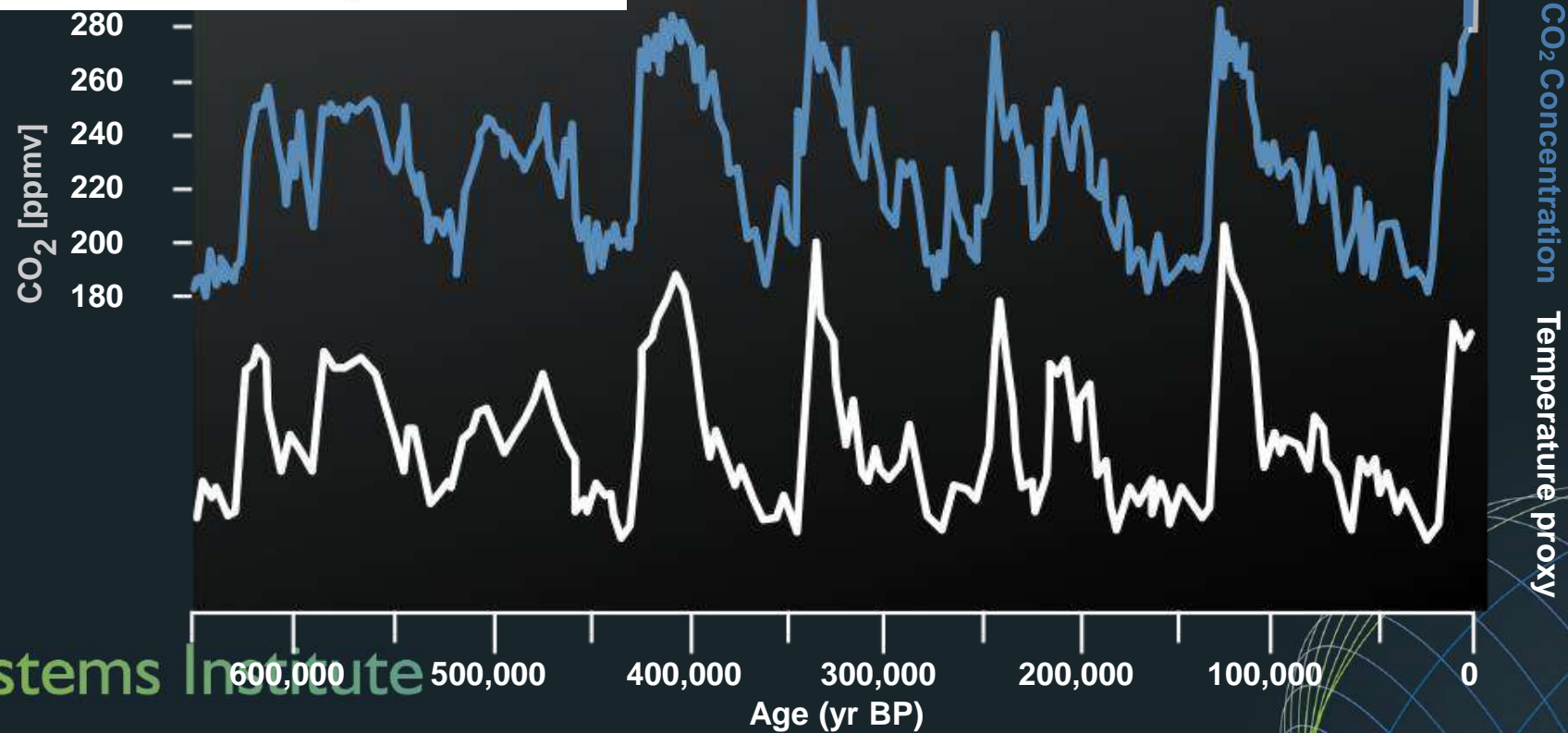
Lenton (2016) *Earth System Science: A Very Short Introduction* (OUP)



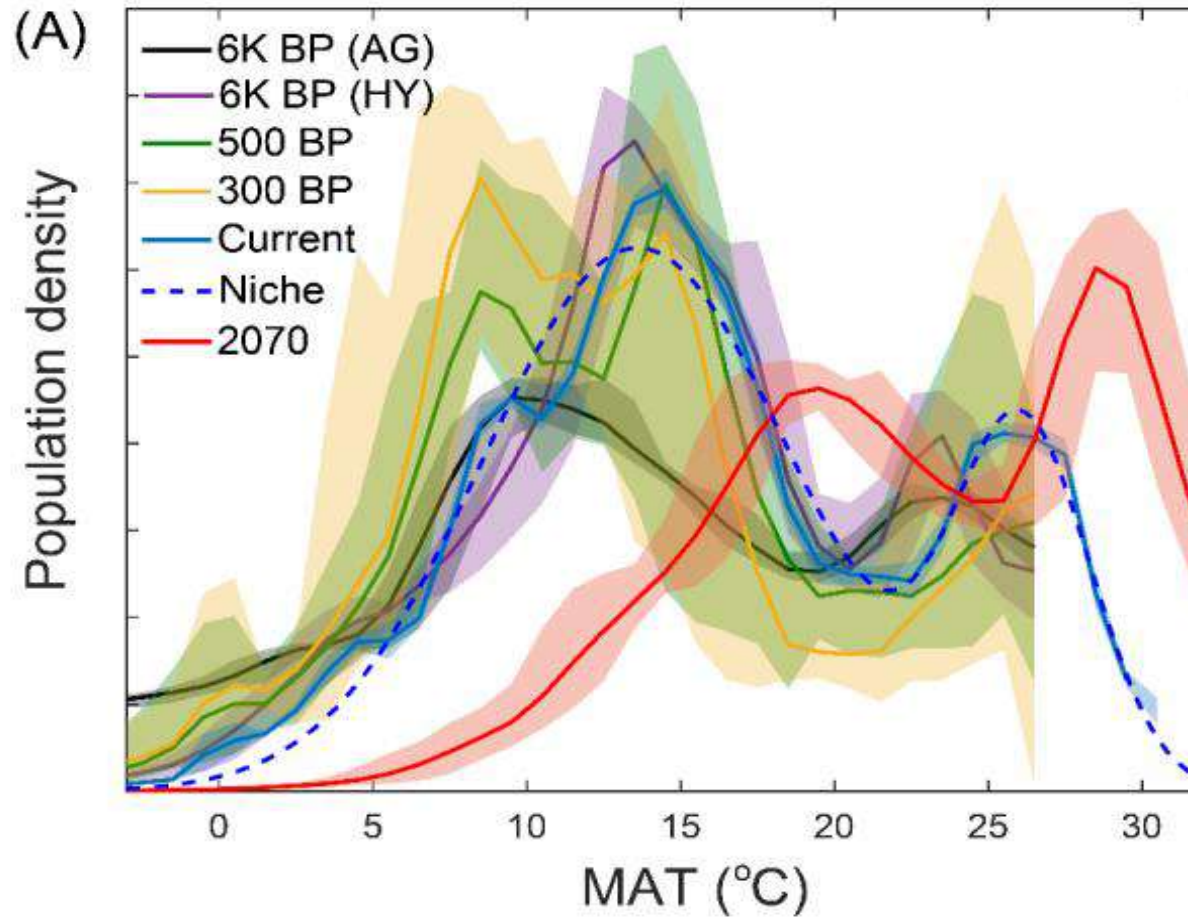


After 40 More Years of current energy use patterns →

Today's CO₂ Concentration →

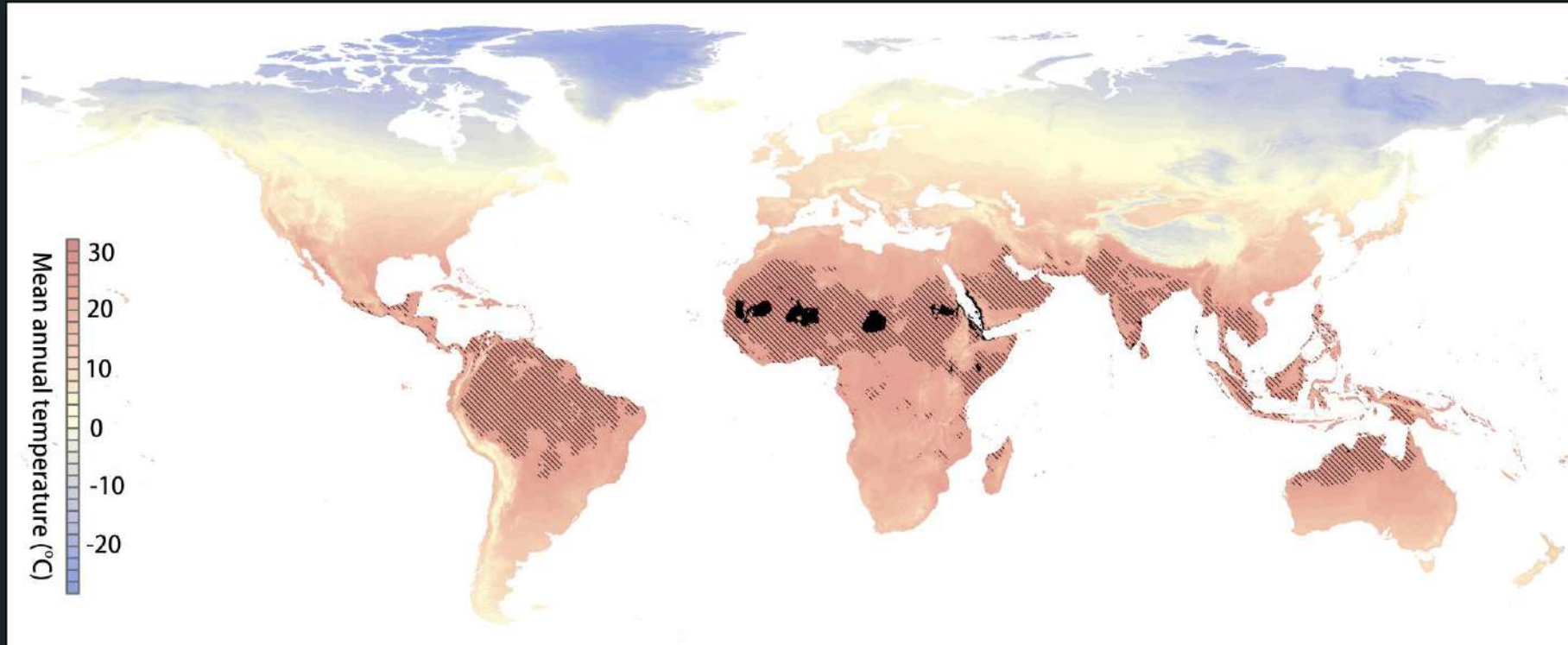


Temperature experienced by humans



Datasets:
AG = ArchaeoGlobe
HY = HYDE

Expansion of extremely hot regions $>29^{\circ}\text{C}$ in a 3°C warmer world



Black areas: where mean annual temperatures $>29^{\circ}\text{C}$ occur today.

Grey shading: where they are projected to occur in a 3°C warmer world (in 2070)

Greenland ice sheet
Ice loss accelerating

Arctic sea ice
Massive reduction in area

Boreal forest
Fire regime changing

Permafrost
Thawing underway

Atlantic circulation
15% slowdown since 1950s

Coral reefs
Massive die offs

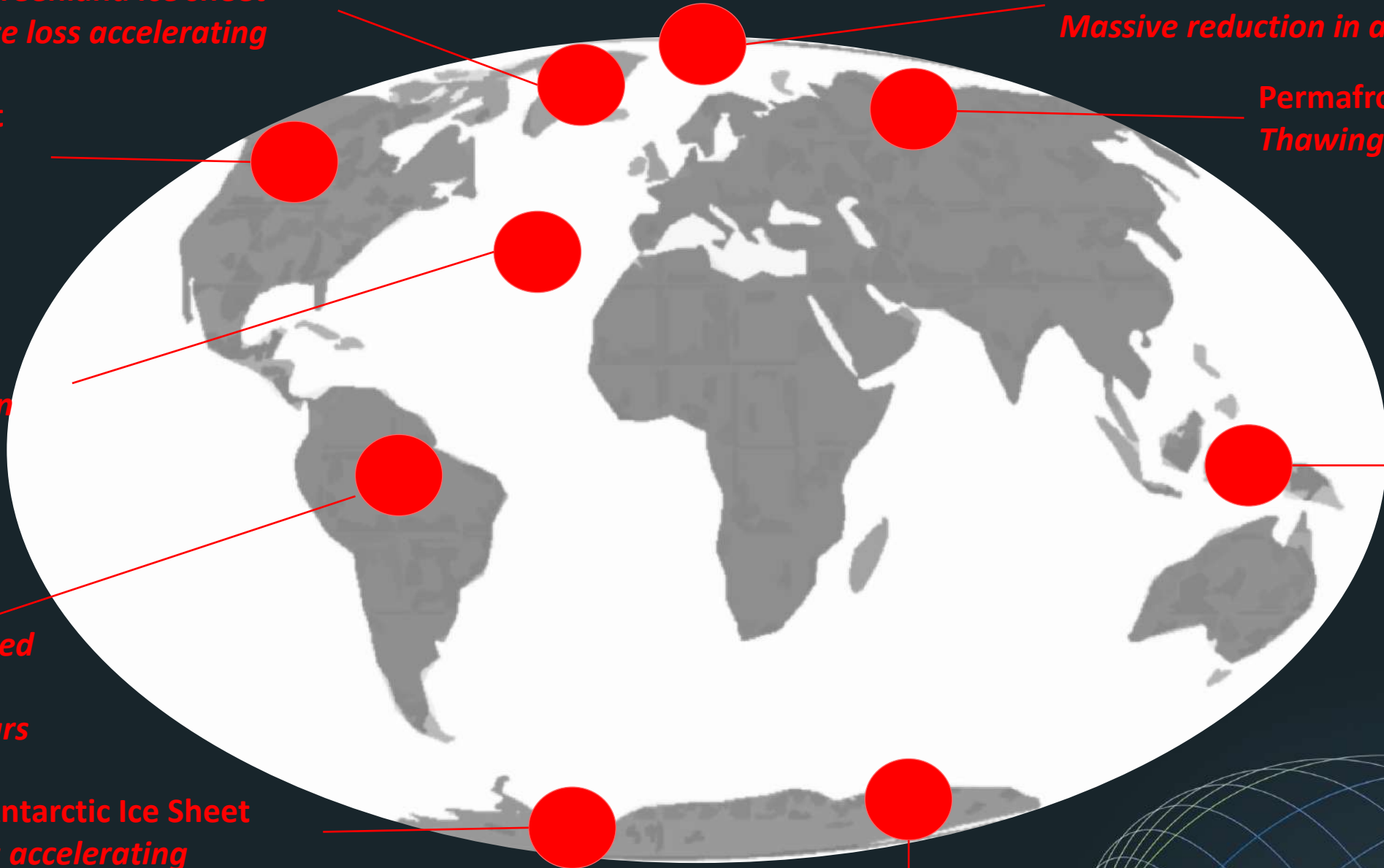
Amazon rainforest
Unprecedented droughts in last 15 years

West Antarctic Ice Sheet
Ice loss accelerating

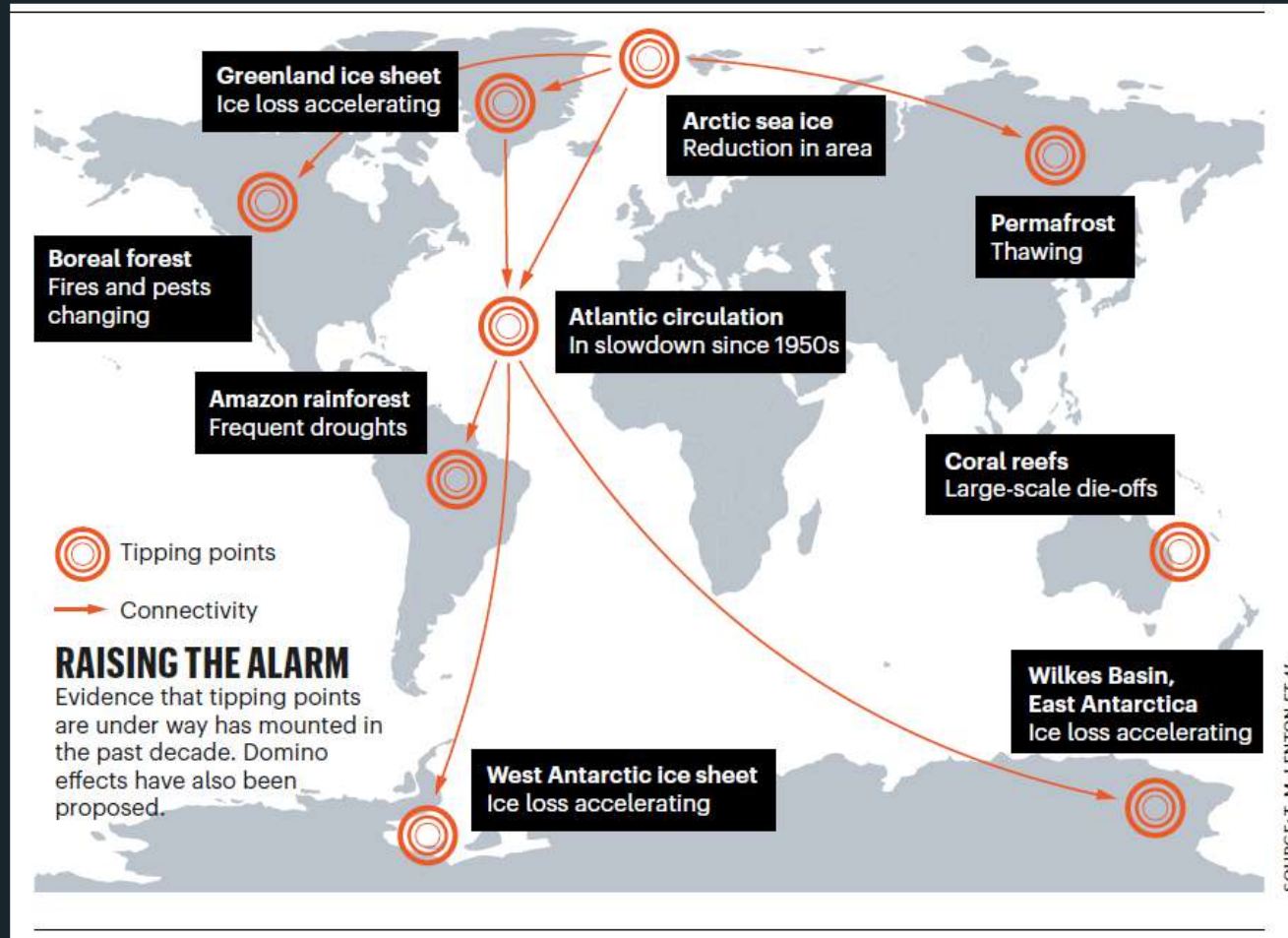
Wilkes basin, East Antarctica
Ice loss accelerating

Global Systems Institute

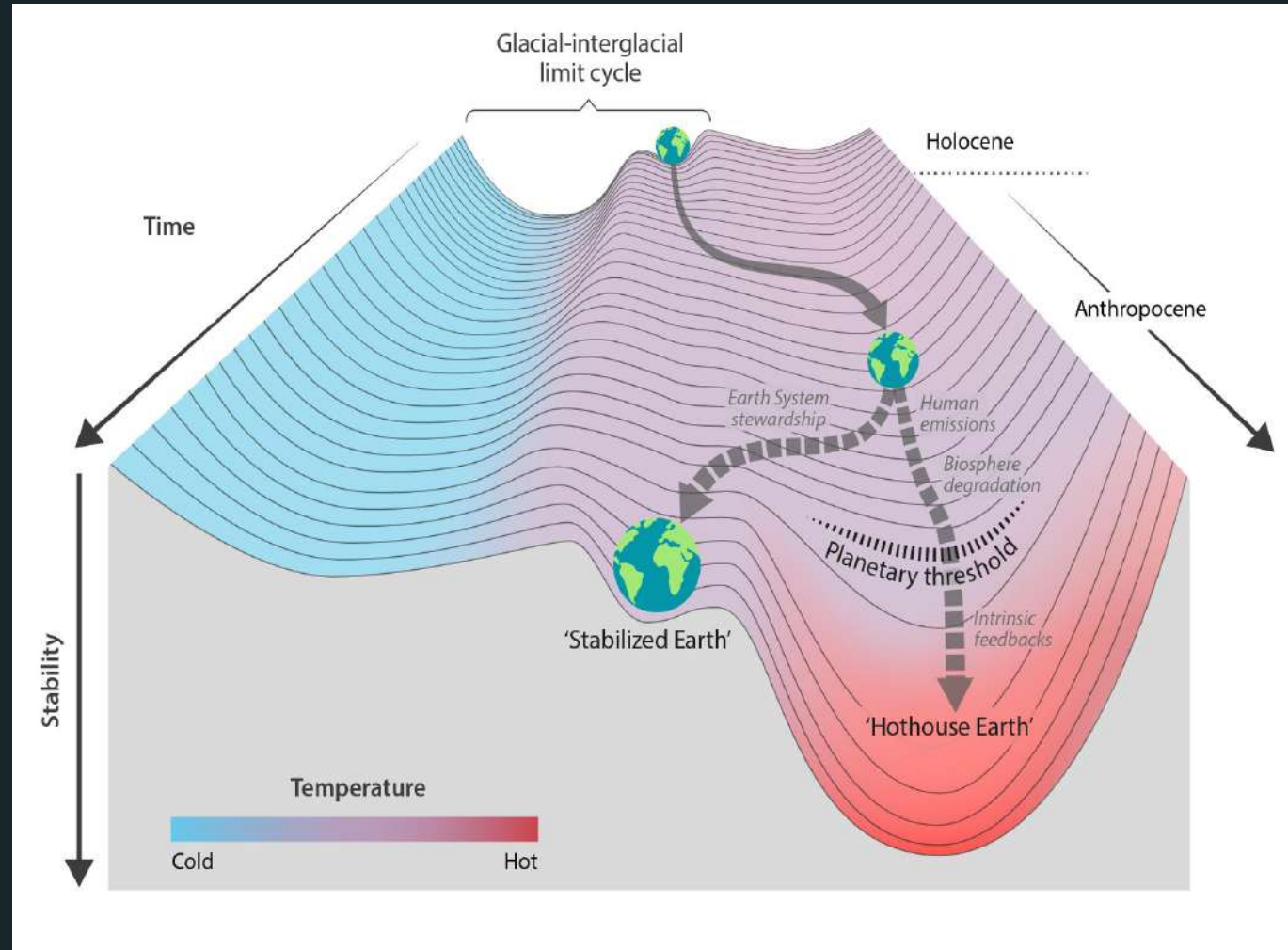
Lenton et al. (2019) *Nature*



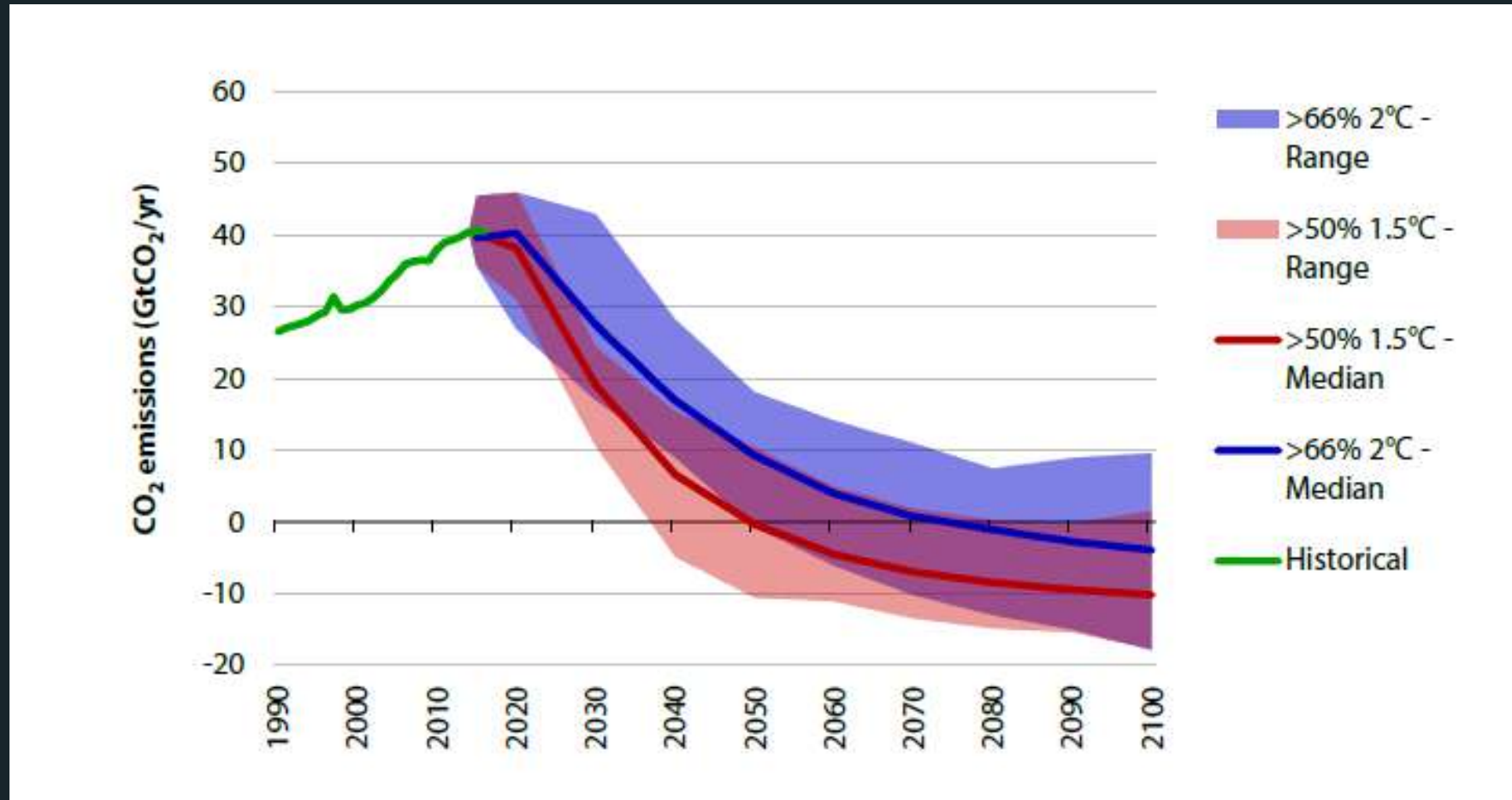
Coupling between tipping elements



A global tipping point?

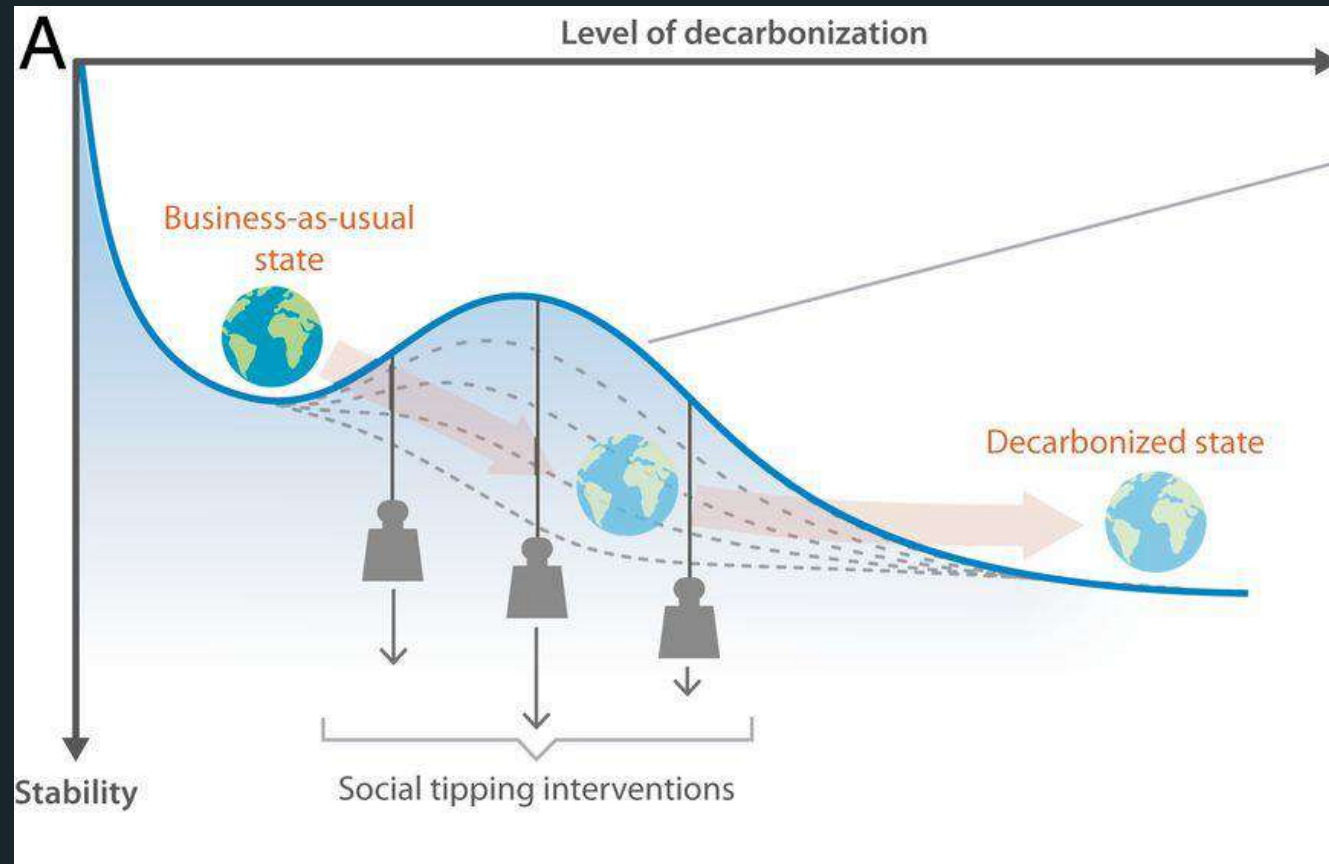


Global CO₂ emissions to meet Paris goals



Committee on Climate Change (2019) *Net Zero: The UK's Contribution to Stopping Global Warming*

Tipping positive change



Otto, Donges et al. (2020) *PNAS* 117(5):2354-2365

Tipping public perception



Tipping social-technical change

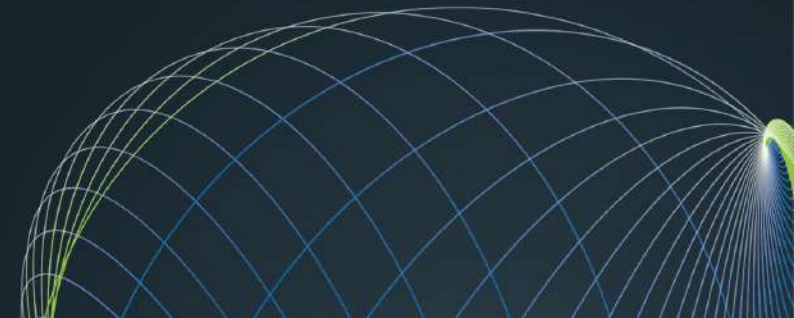
Easter Parade, 5th Avenue, New York City

1900: Spot the automobile



Source: US National Archives.

1913: Spot the horse

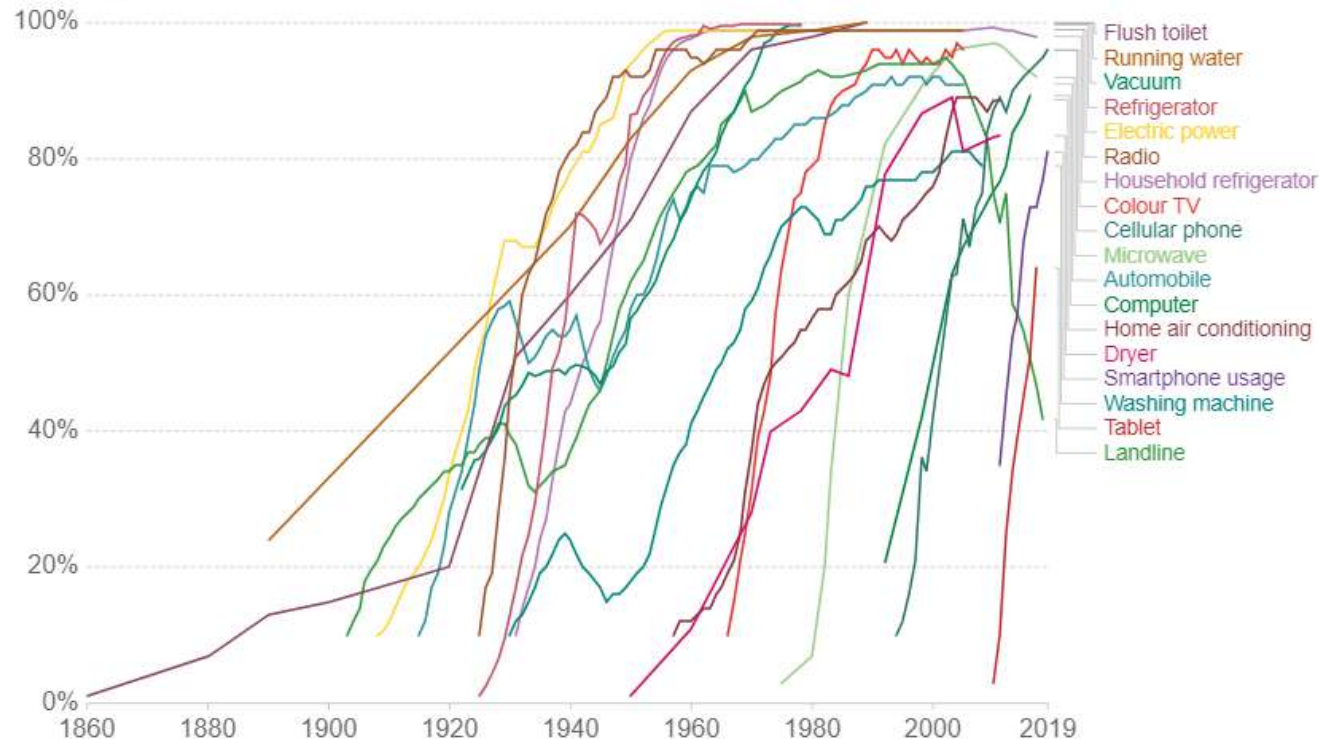


Reinforcing feedbacks in technology diffusion

Technology adoption in US households, 1860 to 2019

Technology adoption rates, measured as the percentage of households in the United States using a particular technology.

Our World
in Data

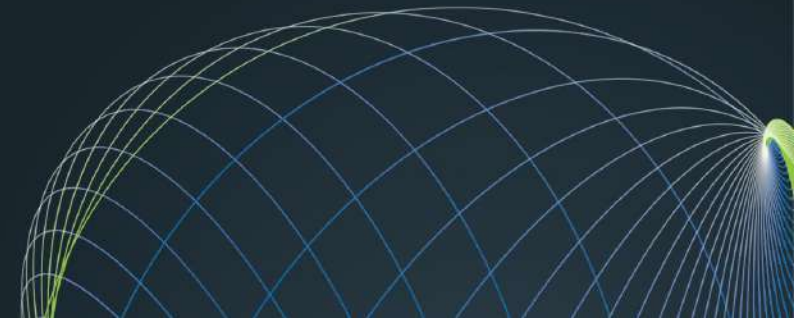


Source: Comin and Hobijn (2004) and others

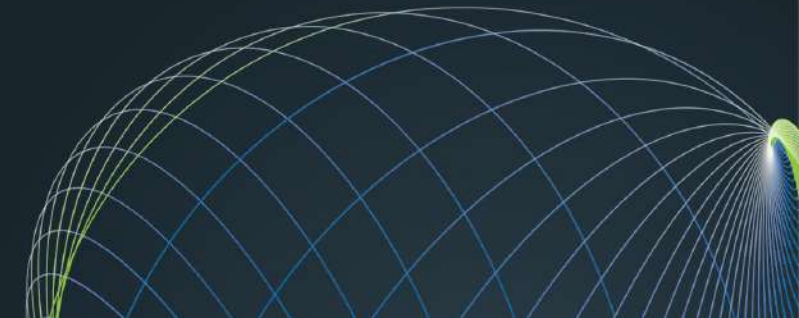
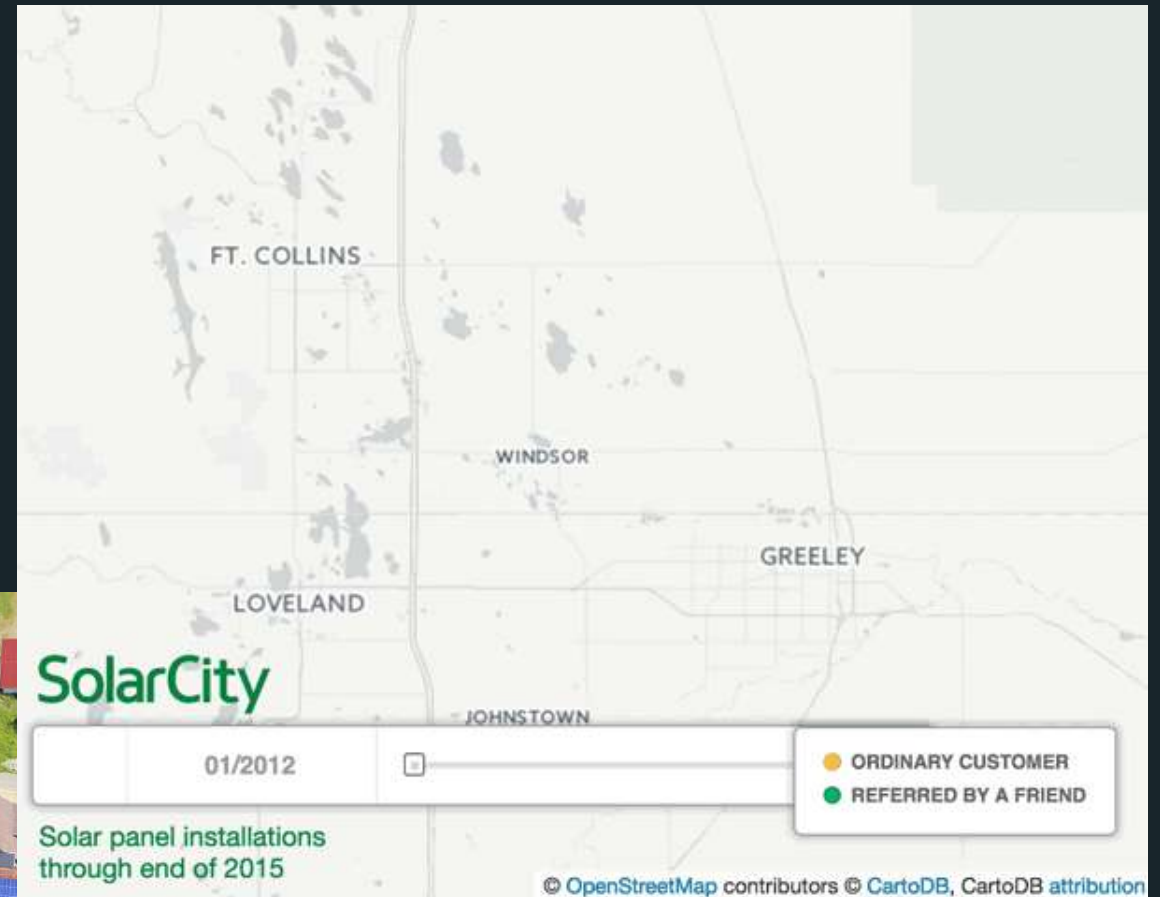
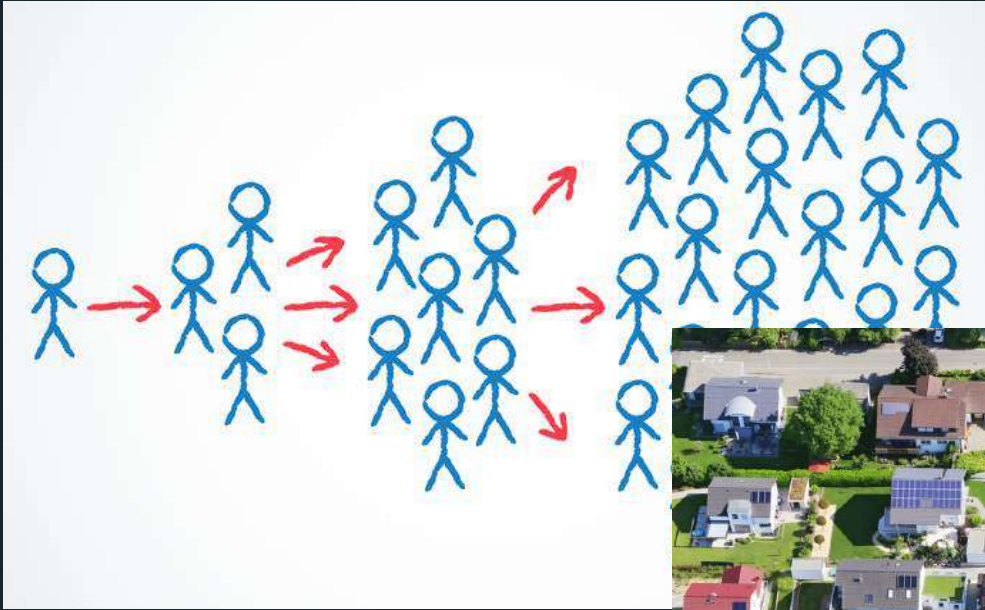
Note: See the sources tab for definitions of household adoption, or adoption rates, by technology type.

OurWorldInData.org/technology-adoption/ • CC BY

- The more something is made the better it can be made (learning-by-doing)
- The more something is made the more cheaply it can be made (economies of scale)
- The more something is used the more technologies emerge that make it more useful

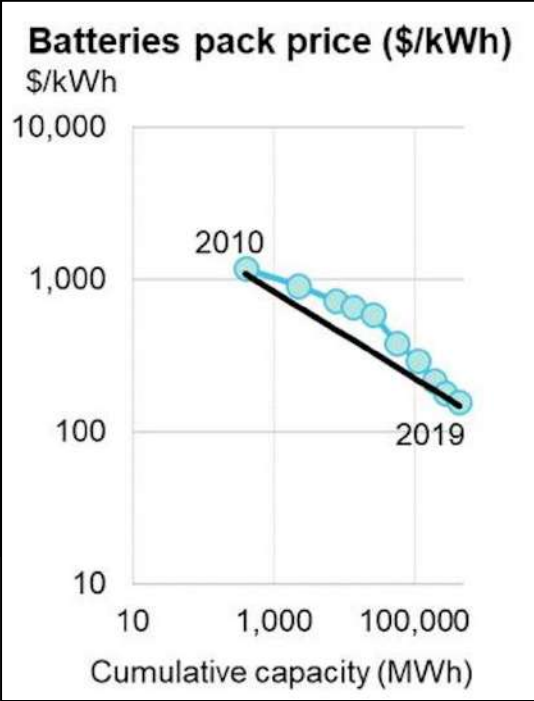
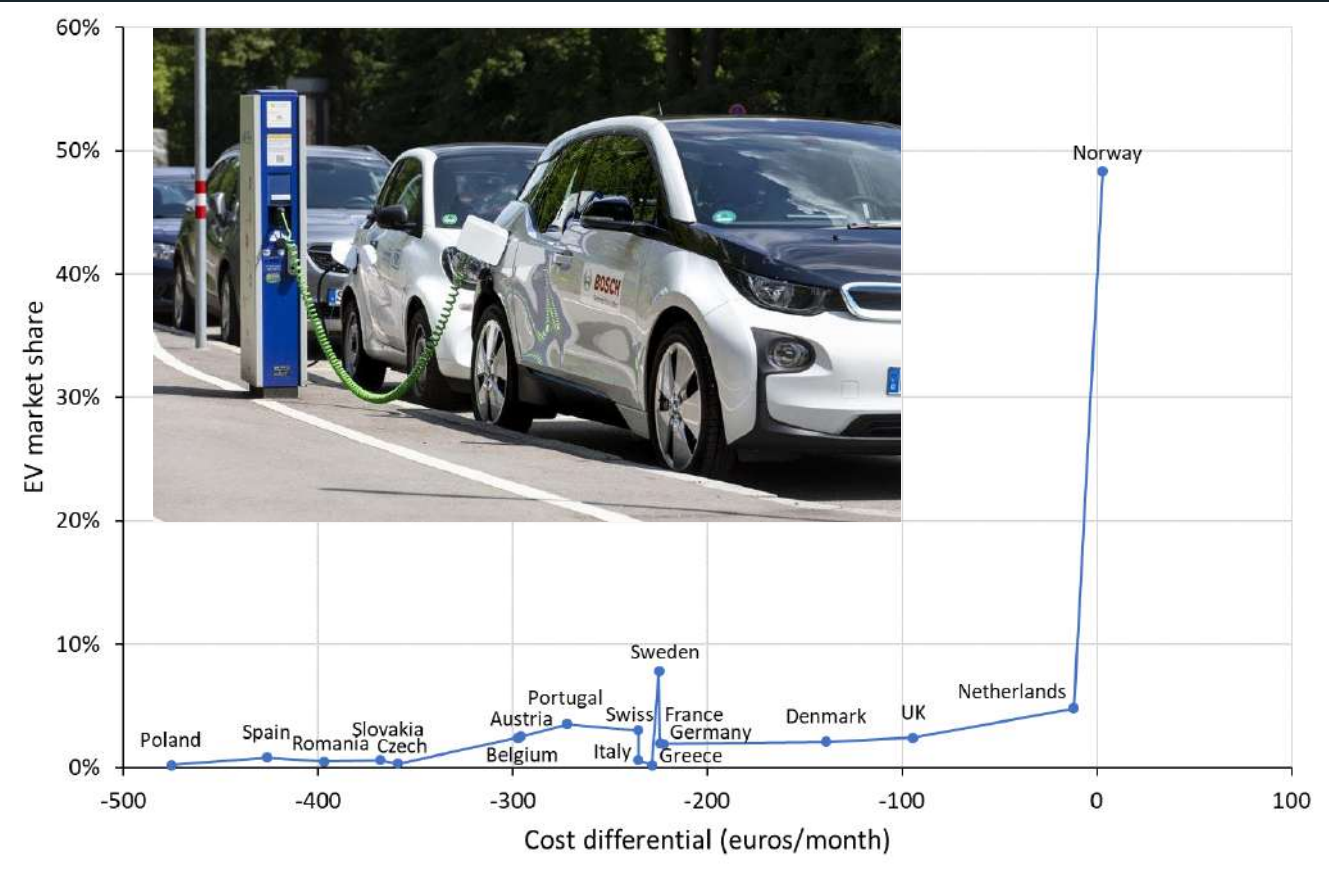


Social contagion

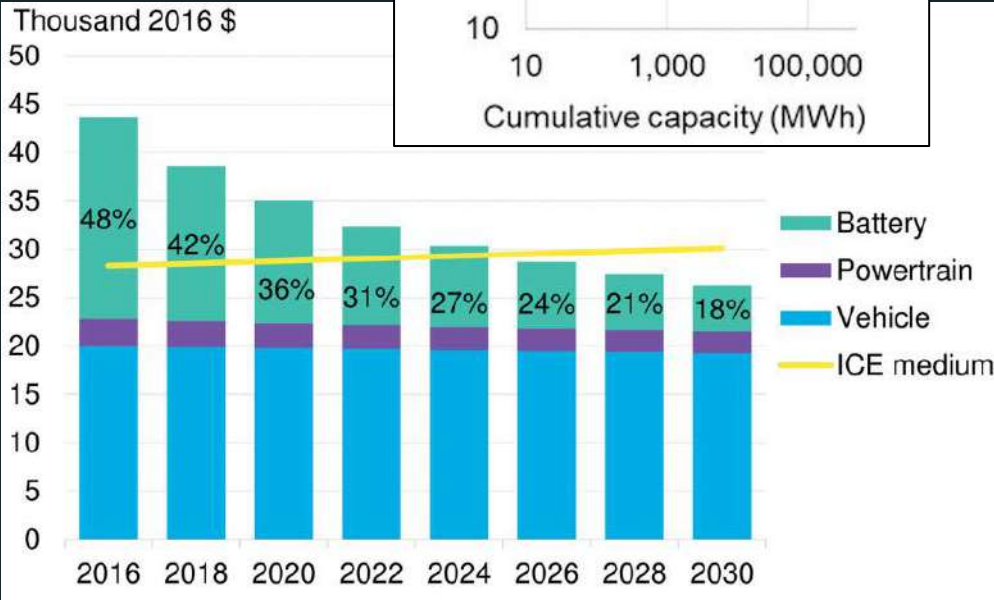


Electric vehicles (EV)

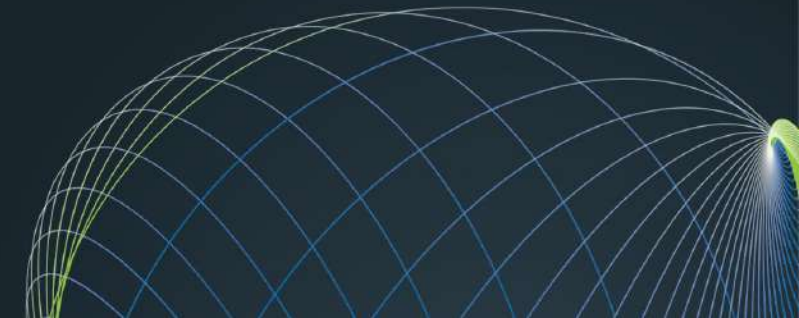
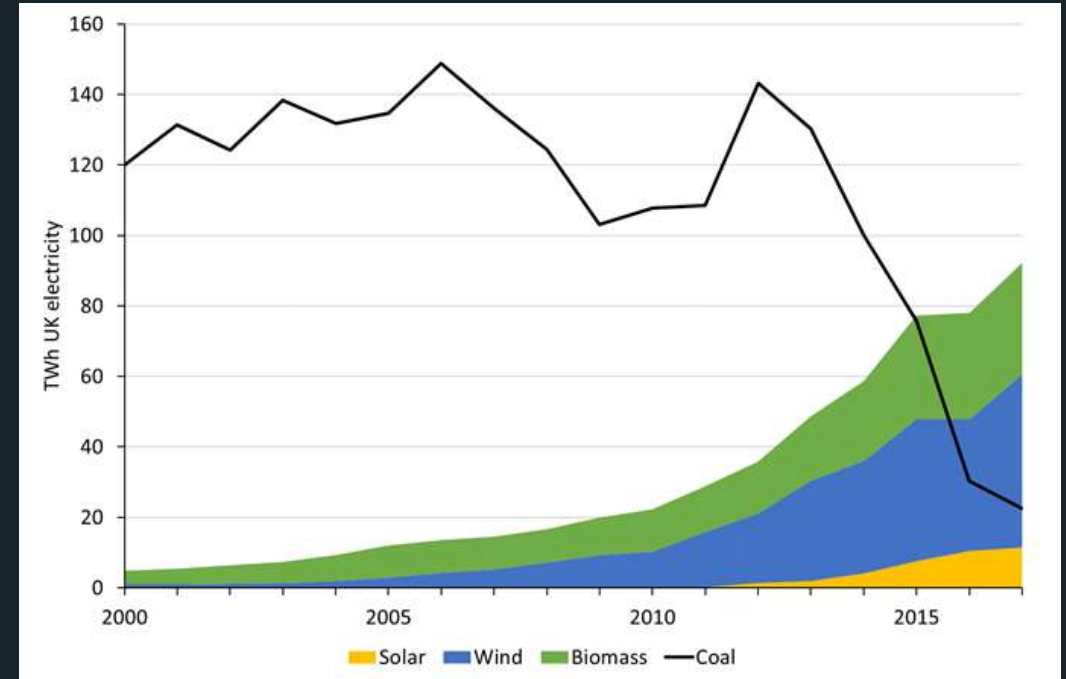
Market share as a function of cost difference to petrol/diesel car



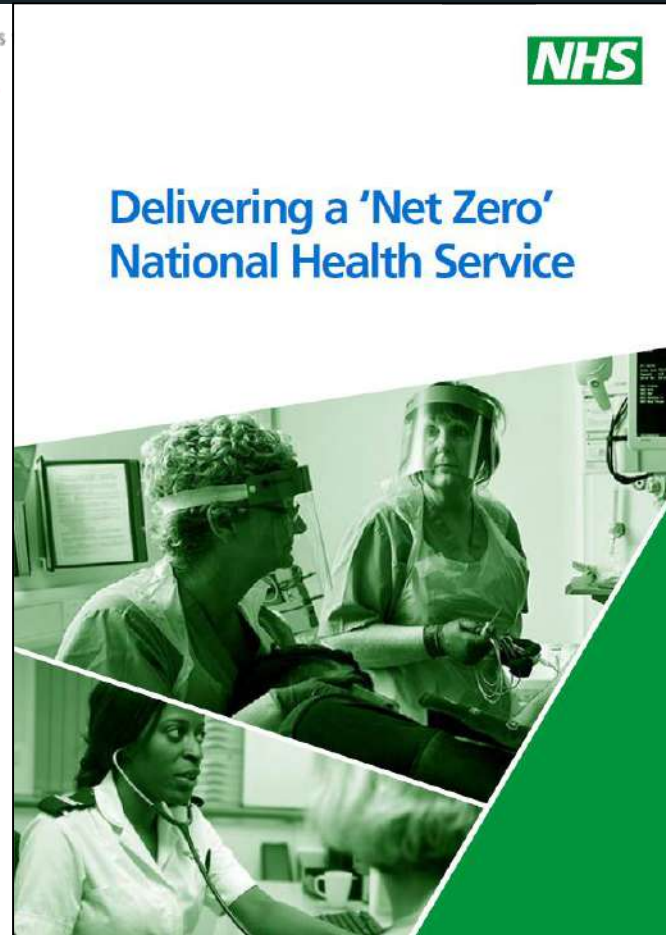
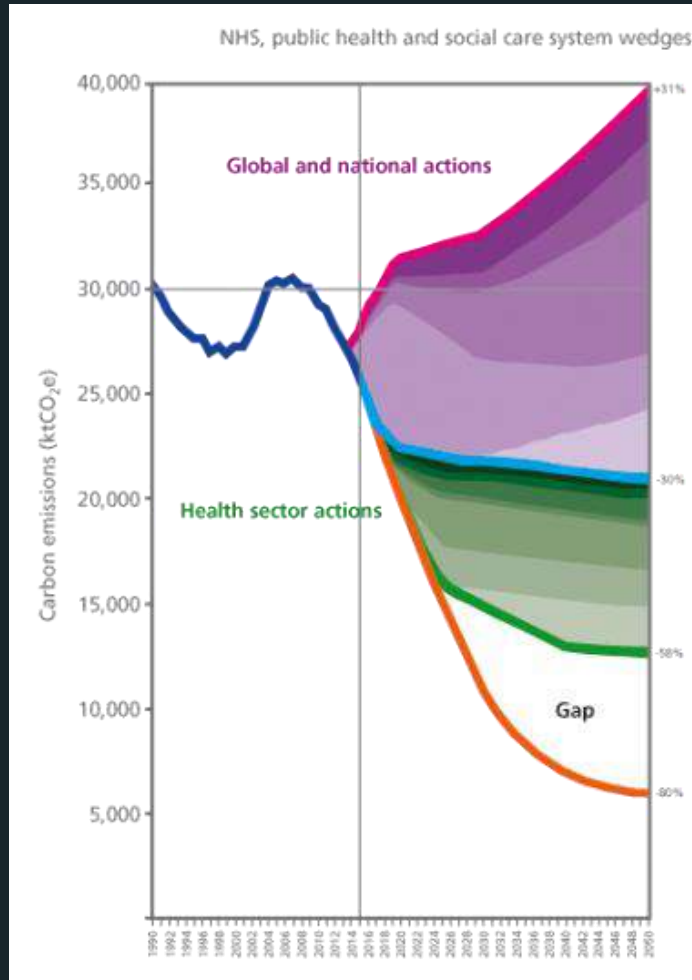
Cost of vehicle



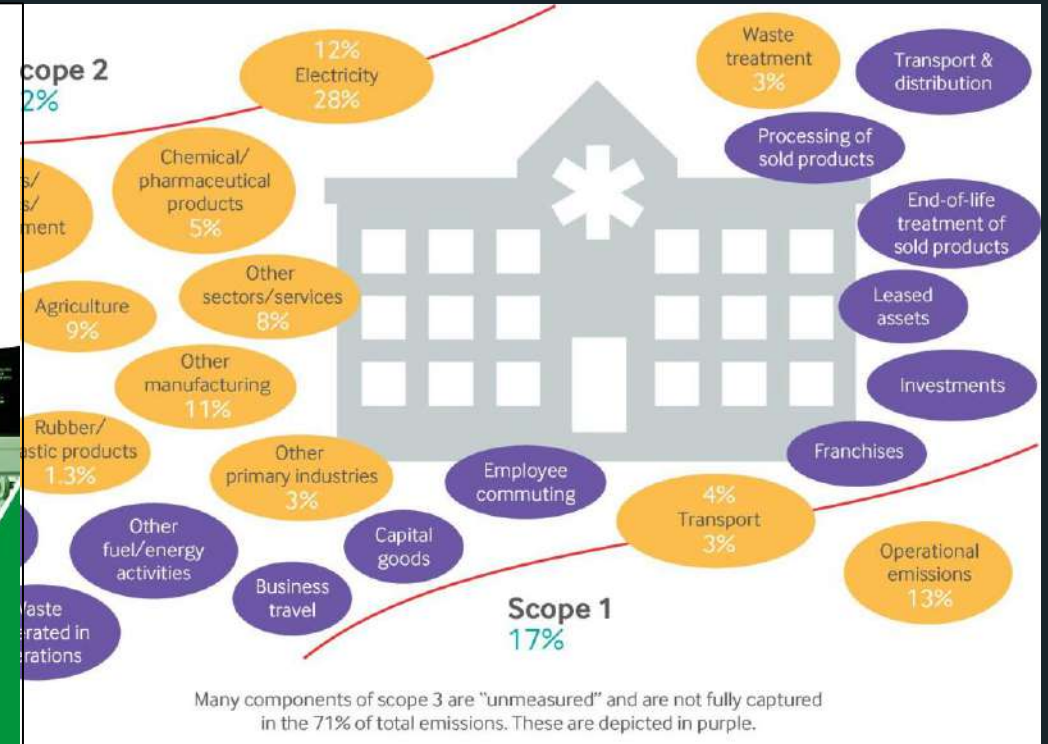
Tipping coal out of UK power generation



Healthcare emissions

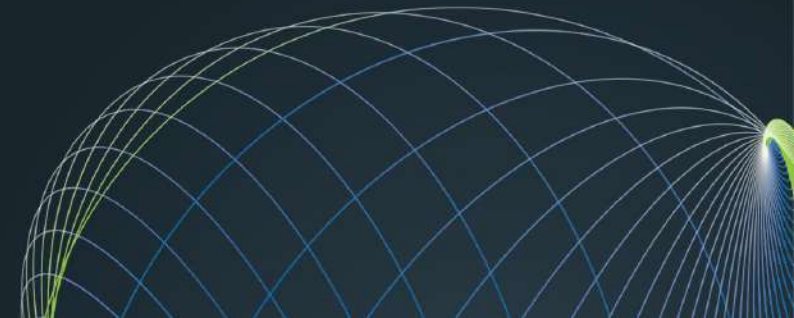
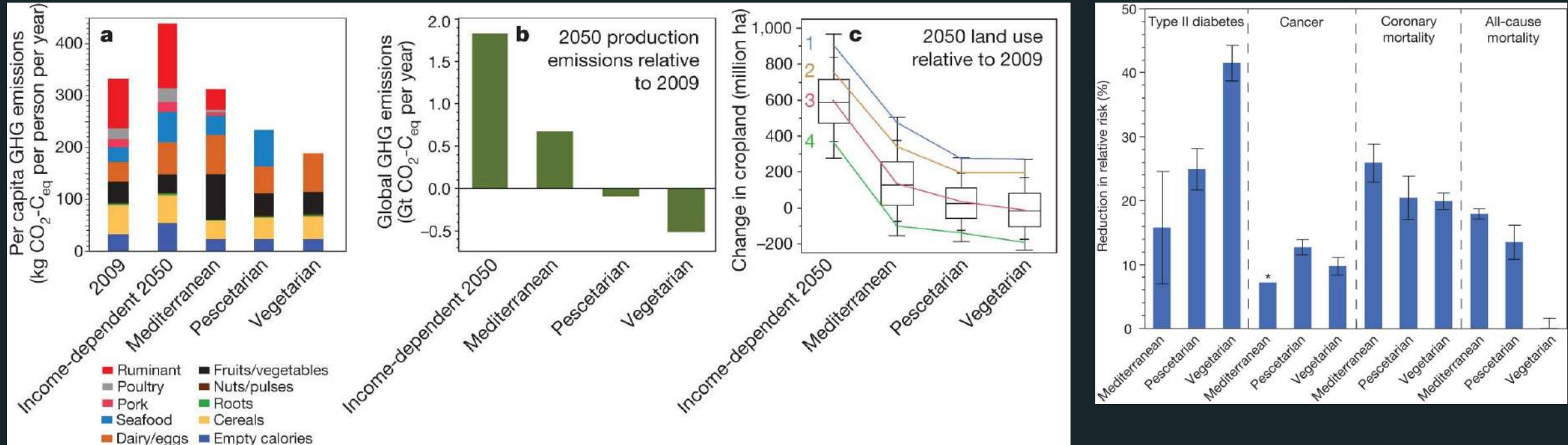


NHS Sustainable Development Unit (2015)

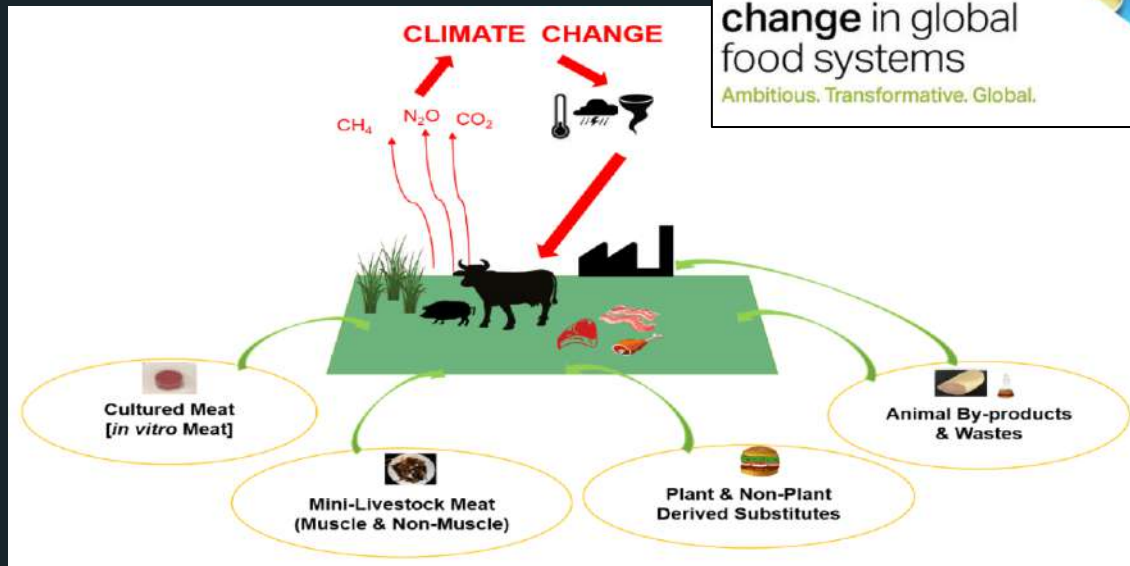


Salas *et al.* (2020) *BMJ* 371: m3785

Dietary change, climate change, and health



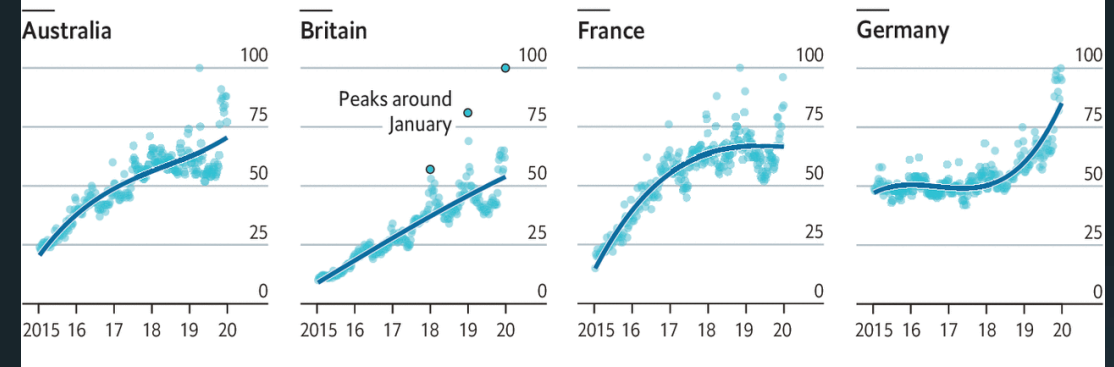
Diet and food system tipping points?



Jiang et al. (2020) *Foods*

A chance of meatballs

Google search interest in "veganism" by country, 100=max



Google Trends/The Economist

Summary

- We live within nested complex systems – the Earth system, ecosystems, social systems (including healthcare systems), and our own bodies
- Complex systems can sometimes pass tipping points where a small nudge transforms them into an alternative stable state
- Some of these are bad – e.g. climate tipping points, ecosystem collapse, death
- But some are good tipping points – and we need to find and trigger them to restore planetary health and secure a safe and just future for humanity
- Positive tipping points for health and for climate can be aligned

