Climate Risk

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What you are looking at here are frozen bubbles of air from almost a million years ago. Ice core samples such as this, extracted from the Antarctic ice sheet, provide a unique record of our past climate.

This reveals how the amount of atmospheric CO2 varied in the past – fluctuating between about 180 and 280 parts per million – as the orbit of the Earth about the Sun slowly changed, moving us in and out of ice ages. An extremely rapid, post-industrial revolution spike has put the value today at an incredible 405 parts per million. This record is one of the most compelling pieces of evidence we have that recent change lies far outside the natural cycle.

We know what has driven this dramatic change.

Since 1850, there has been an explosion in human activities that generate carbon dioxide, as we have burned vast quantities of fossil fuels for energy and developed the land surface. You can see the rapid change in global GDP and in global energy use in these two graphs.

As a "greenhouse gas", one would expect that an increase in carbon dioxide to be accompanied by an increase in temperature of the Earth's surface. And indeed the temperature, averaged over the surface of the land and oceans, has increased by about 1 degree Celsius since the late nineteenth century.

As the ocean waters have warmed they have expanded in volume and together with melting ice from glaciers and the polar ice sheets, this has raised sea levels globally.

Together this data provides a dashboard describing how our climate is changing and how that change is largely due to human activities.

Data coming from climate models shows the risk of future climate change in terms of global temperature and sea level. Global temperature is used as the key metric framing policy, with the Paris Agreement committed to keep temperatures well below 2C with an ambition to reach 1.5C.

Now let's consider then the climate risk to business and investment with a view to how climate science and polar expertise can guide decisions.

The Task Force on Climate-related Financial Disclosures considers three categories of risk. Transition risk – the risk from competition or of market volatility associated with a transition to a green economy. Physical risk – the risk of damage to assets and resources or of the disruption of trade from the impacts of climate change. And liability risk – in particular the risk of litigation around climate change. There is an increasing awareness of the pervasiveness of these risks: for example, uninsured property is a physical climate risk for banks.

In particular with regard to estimation of physical and liability risks, the global average picture of the previous sets of data I showed is not sufficient to inform decision-making.

The first important aspect that is missing is local information. For understanding physical risk, granularity matters. The population weighed average temperature, which accounts for where people live, has been increasing at twice the global average over recent decades. The Arctic for example has seen the greatest warming, impacting daily life for those who live there and the extent of Arctic sea ice is plummeting, with September sea ice coverage today being less than two-thirds of that at the end of the twentieth century. Sea level rise too show significant regional variability.

The second thing that is missing is a description of tail risk. In most instances, the most material risk comes from extreme weather conditions, not changes to the average conditions. It is already the case that the risk of many instances of extreme weather has increases as a result of the climate change observed to date – including all the instances in orange here.

For example, the risk of the sorts of heavy rainfall associated with some of the terrible flooding seen in the UK in recent years – such as in 2014 – has increased as a result of climate change. That, combined with sea level rise, also exacerbated the storm surge flooding associated with catastrophic hurricane season last year.

High temperatures, especially when combined with high humidity can prove deadly to vulnerable groups. It is estimated that already today 30% of the world's population experience such potentially deadly conditions each year.

Far-away disasters in 2016 were linked as climate change exacerbated the effects of El Nino resulting, for instance, in a terrible drought in Southern Africa and an extreme heatwave in southeast Asia. In a world connected by global supply chains, it is vital to understand these sorts of correlated risks.

But tail risk is not only about extreme events, it is also about black swan events – the risk of catastrophic change occurring. We know that dramatic and rapid regional change in temperature can occur: in the North Atlantic, there are more than 20 examples of this in the last 100 thousand years. As can be seen from this Greenland ice core record, at the end of the last ice age there were numerous abrupt swings in temperature of up to 10 degrees Celsius in as little as a decade.

Recent millennia have been characterised by unusual stability. But it is clear that as temperatures increase, the risk of triggering black swan events increases. It has happened in the past; it could happen in the future. For some systems this is a concern even within the Paris Agreement limits.

Modest temperature rise may threaten the vast ice sheets covering Greenland & West Antarctica as David Vaughan will describe in more detail. Such changes to the polar ice sheets would lead to seas eventually rising by metres, transforming global coastlines, destroying infrastructure and displacing hundreds of millions of people.

This leads on to the third thing that is missing: the connection between the climate change and its impacts. Taking its impact on supply chains or other business operations, we need to know for example, not just how winds might change in the future, but how that will affect the viability of wind farms – and indeed we have a paper coming out this week on exactly that [Hosking et al, 2018]. Practical information that can guide decision-making. We also need information concerning the impacts on human well-being, for example on food security and human health, and the impacts on wildlife and ecosystems – including some of the incredible species like this Antarctic ice fish that reside in the polar regions.

Today we are at a crossroads. This graph shows the current trajectory of CO2 emissions in black and a set of pathways for future emissions in blue that are broadly consistent with the Paris Agreement. Decisions made today will determine whether we follow this blue path of limited future climate change, or whether we continue as we are along a red trajectory to a very different world.

Climate science and polar expertise is providing vital input to policy decisions at a national and international level. But it can also be used to guide the decisions of businesses, investors or civil society groups in terms of the scale and speed of emissions reductions required and with regard to how to adapt and build resilience to future climatic changes.

References

Hosking et al, 2018, Changes in European wind energy generation potential within a 1.5°C warmer world, European Research Letters, http://iopscience.iop.org/article/10.1088/1748-9326/aabf78

Climate Risk

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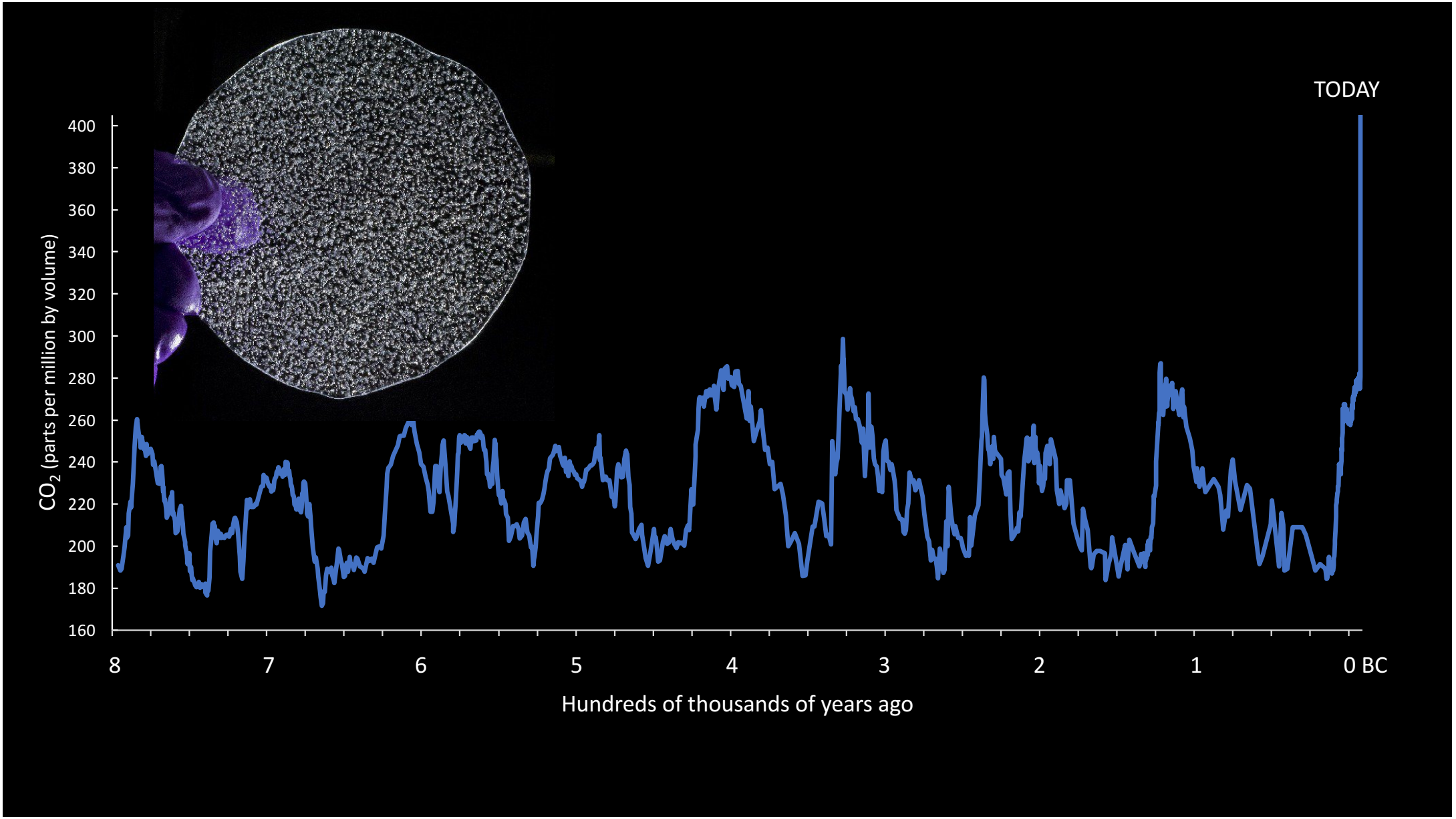
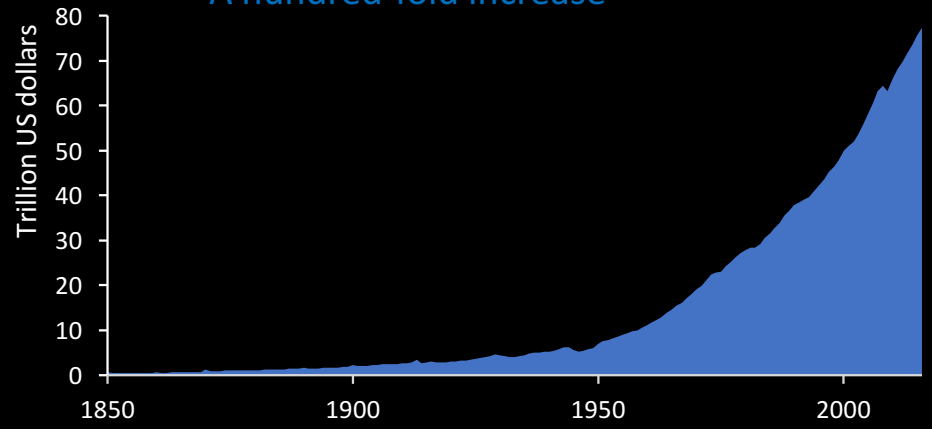

TODAY
400
380
360
340
320
300
280
260
240
220
200
180
160
CO_2 (parts per million by volume)
8
7
6
5
4
3
2
1
0 BC
Hundreds of thousands of years ago

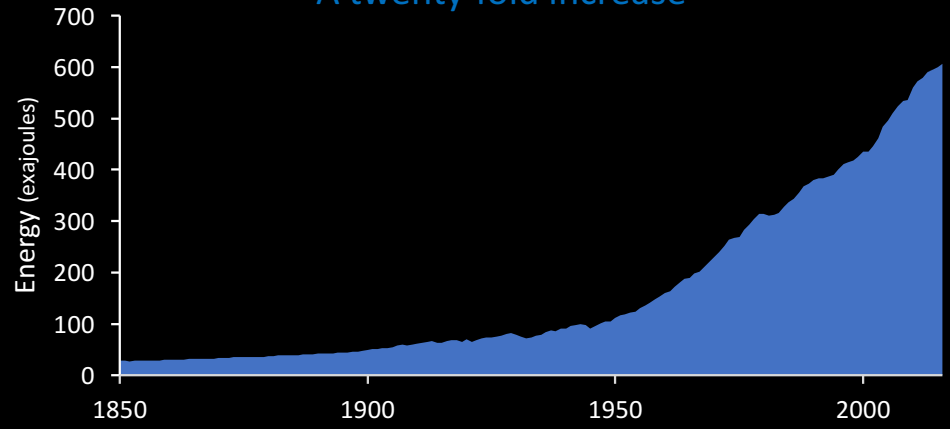
Global GDP

A hundred-fold increase



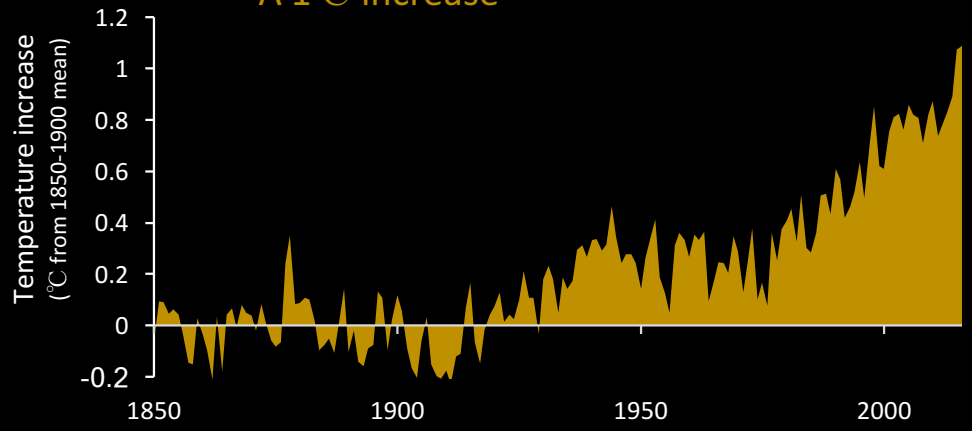
Global energy use

A twenty-fold increase



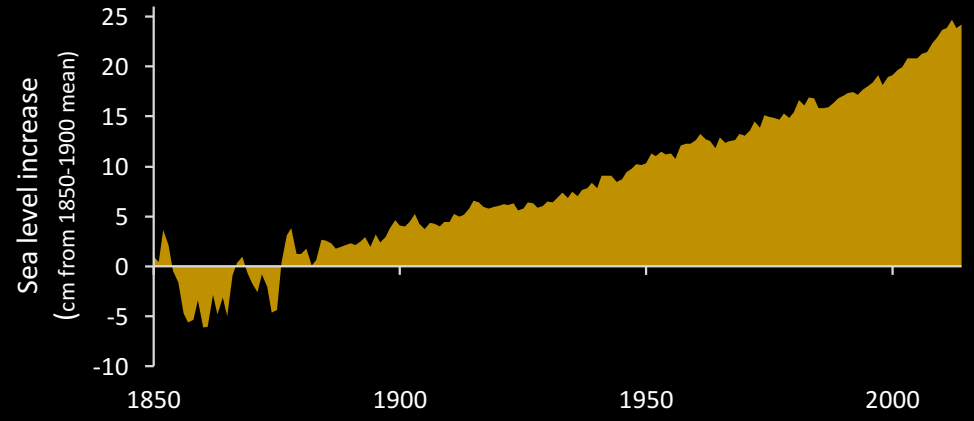
Global surface temperature

A 1℃ increase



Global sea level

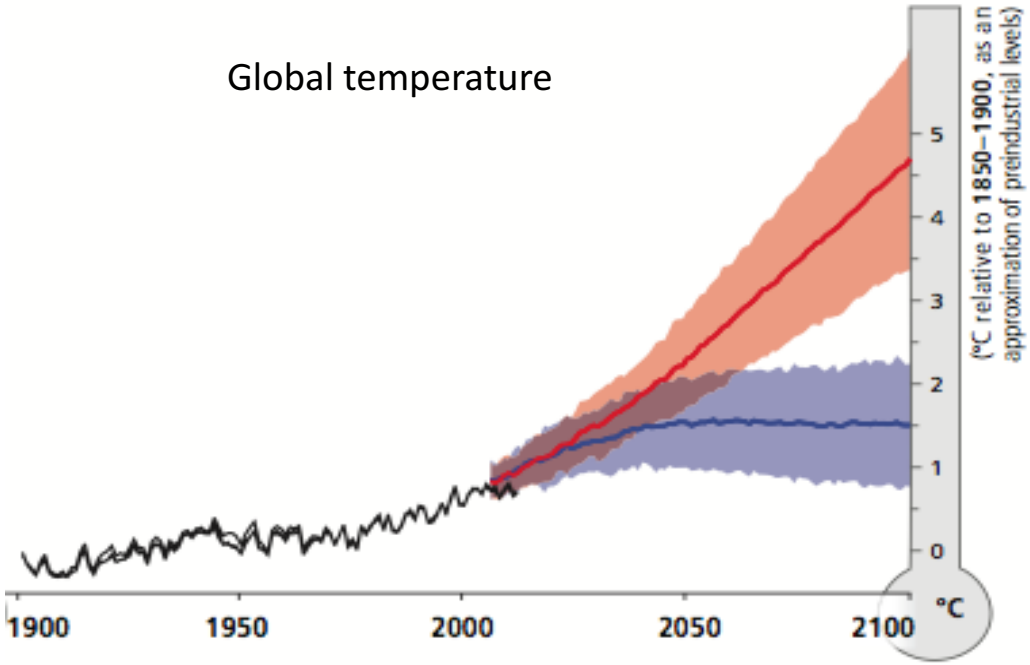
More than 20 cm increase



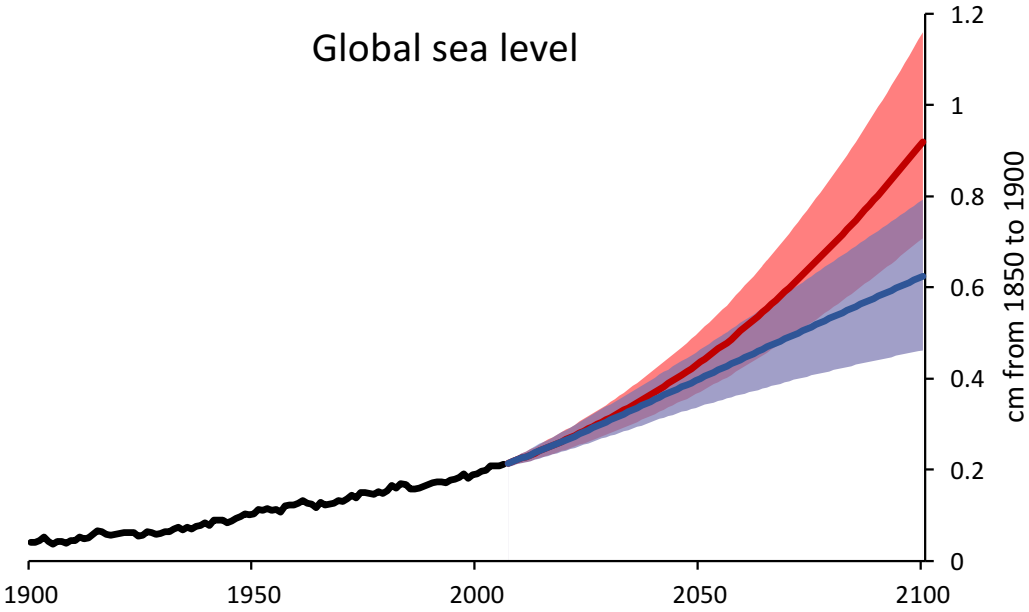
"Paris Agreement"

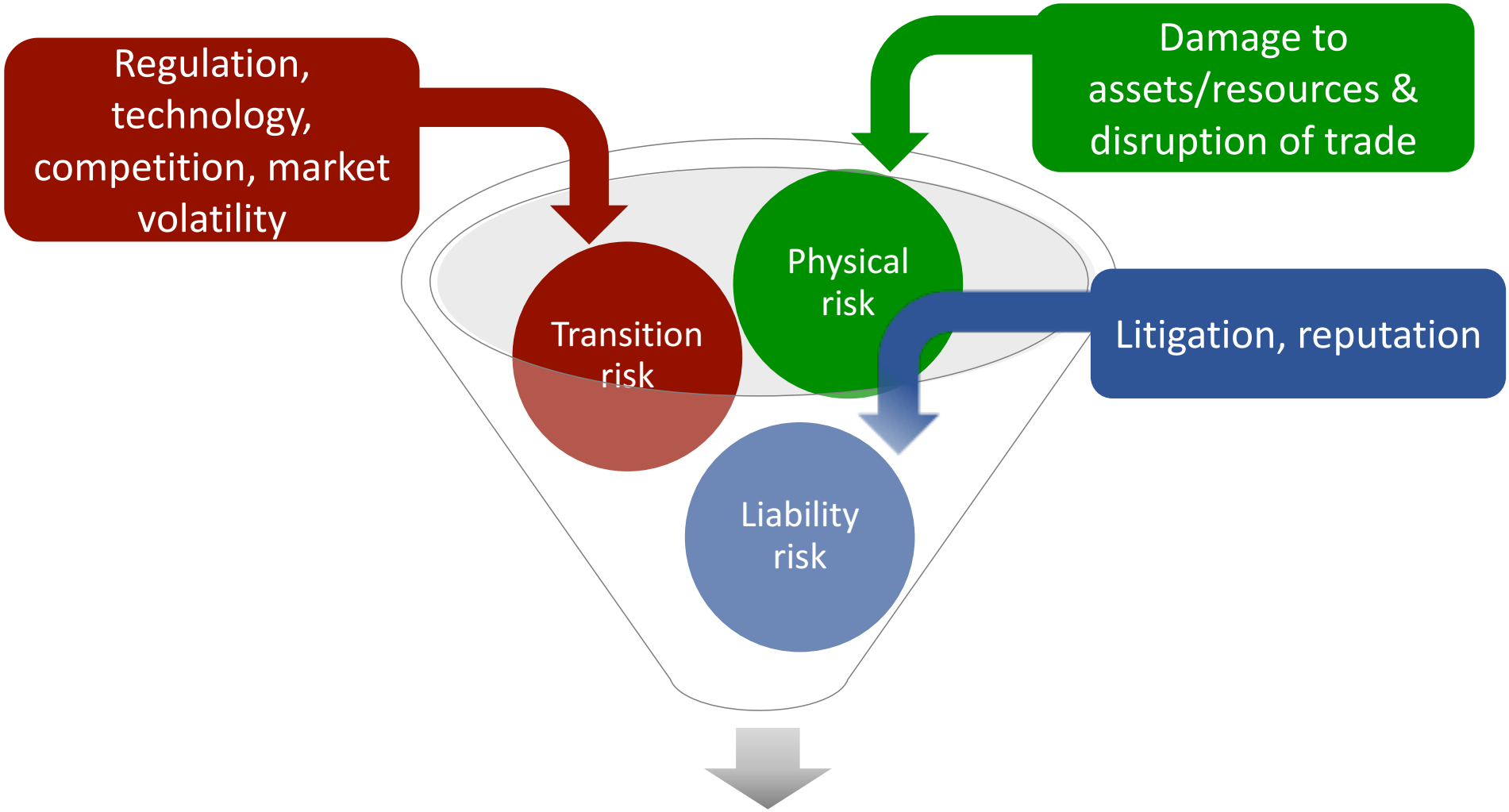
"Business as Usual"

Global temperature

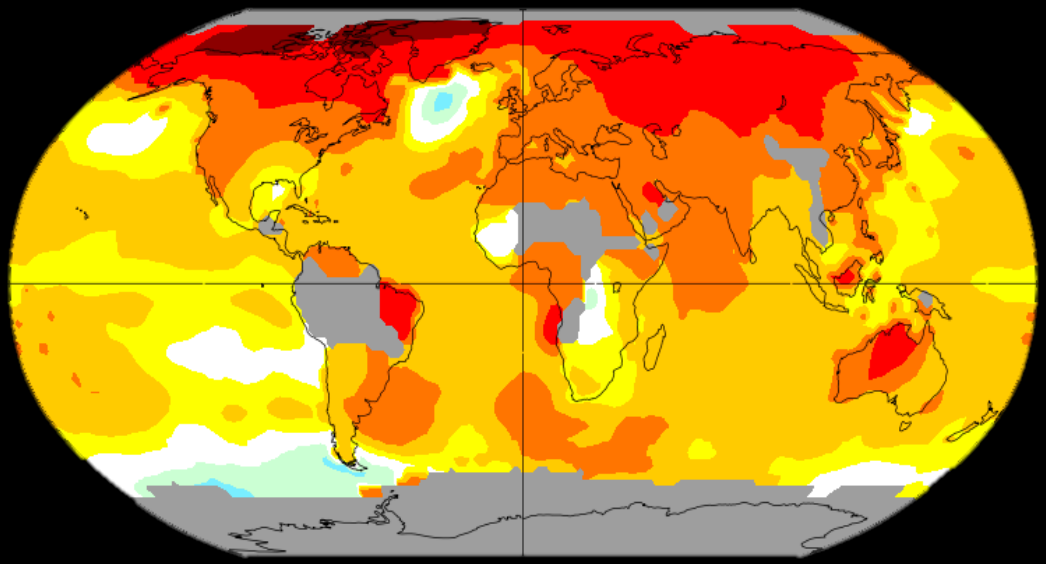


Global sea level




Regulation, technology, competition, market volatility
Damage to assets/resources & disruption of trade
Transition risk
Physical risk
Litigation, reputation
Liability risk
Climate risk to business & investments

Temperature 2007-2017 vs 1880-1900

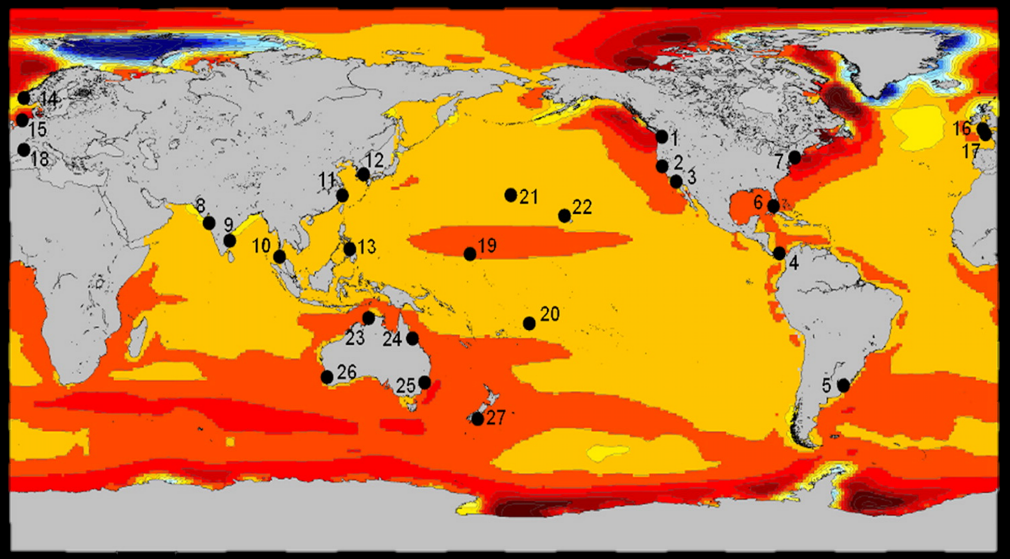


-4 -2 -1 -0.5 0 0.5 1 2 4 ℃

insufficient data

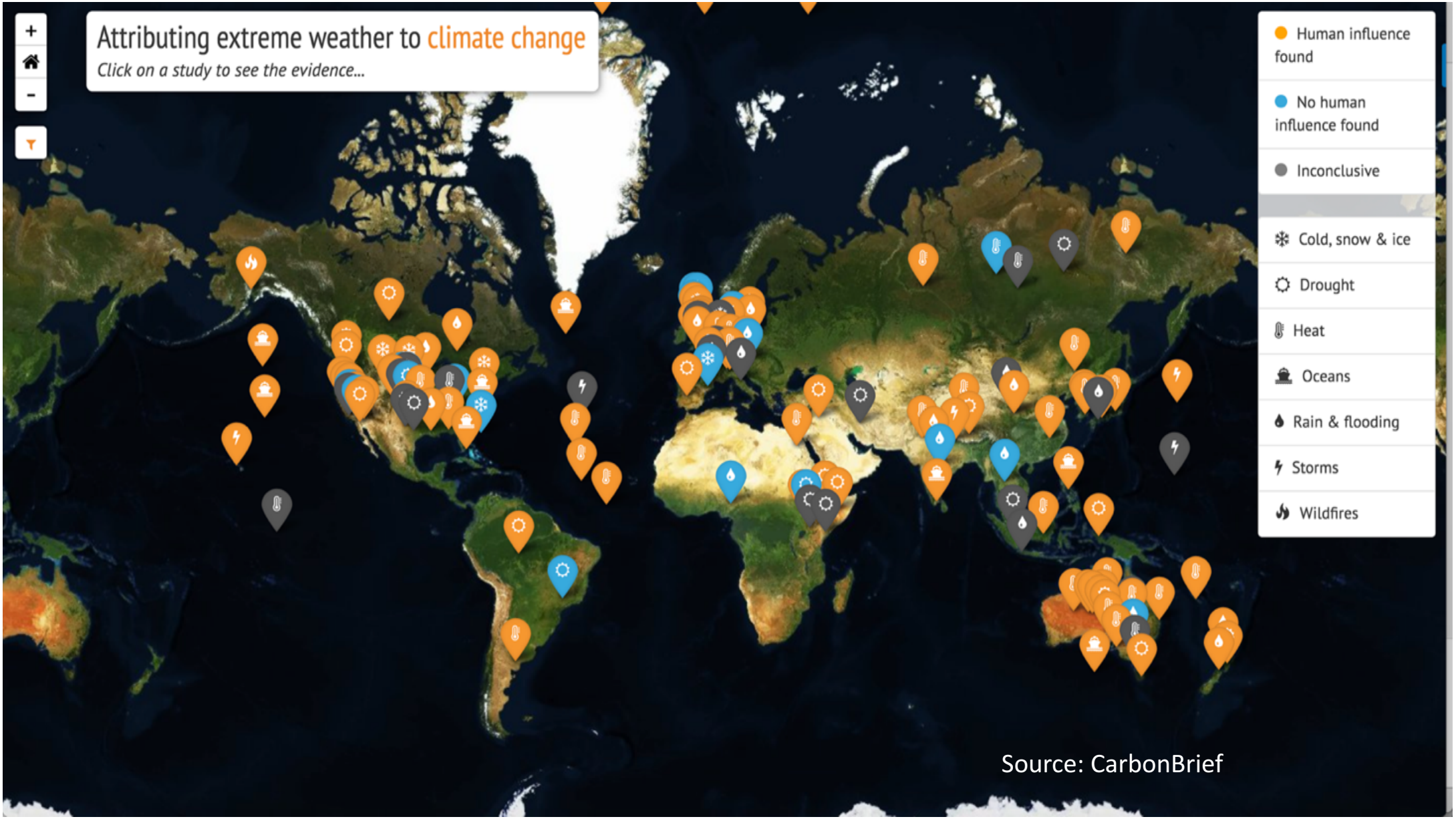
Source: NASA

Sea level 1996-2015 vs 1901-1920



-30 -20 -10 0 10 20 30 cm

Source: Meyssignac et al, 2017


Attributing extreme weather to climate change
Click on a study to see the evidence...
Human influence found
No human influence found
Inconclusive
Cold, snow & ice
Drought
Heat
Oceans
Rain & flooding
Storms
Wildfires
Source: CarbonBrief


Attributing extreme weather to climate change
Click on a study to see the evidence...
Schaller et al, 2016
Thirumalai et al, 2017
Van Oldenborgh et al, 2017
Funk et al, 2018
Human influence found
No human influence found
Inconclusive
Cold, snow & ice
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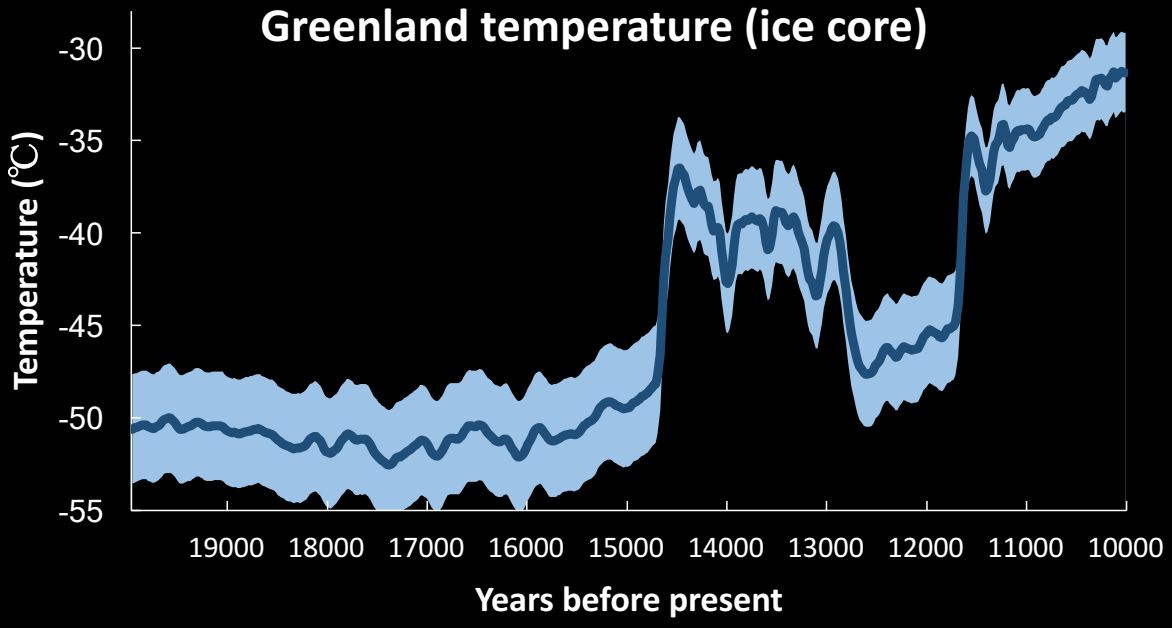
Wildfires

Risk of catastrophic change

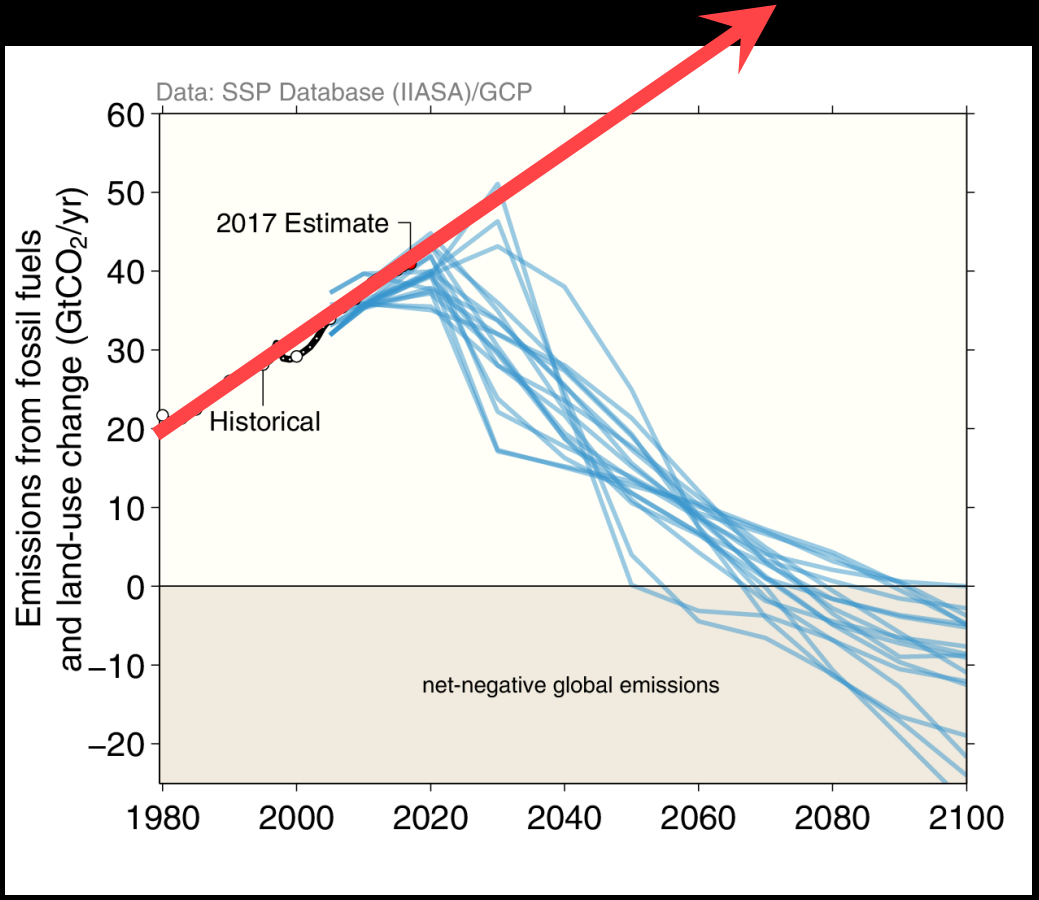


Climate change impacts

Business operations

Human wellbeing

Natural world


Data: SSP Database (IIASA)/GCP
Emissions from fossil fuels and land-use change ($GtCO_2$/yr)
60
50
40
30
20
10
0
−10
−20
2017 Estimate
Historical
net-negative global emissions
1980
2000
2020
2040
2060
2080
2100