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Climate Crisis

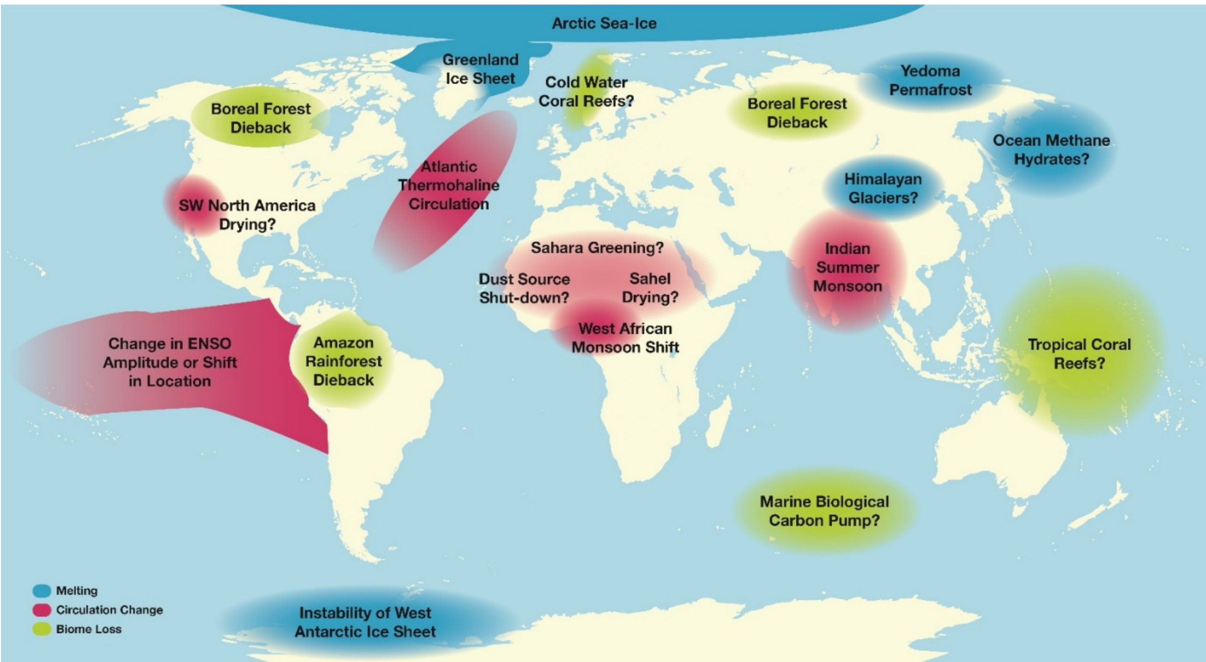
Background Information for Teachers

In October 2019, the Guardian newspaper stopped referring to climate change, using the terms ‘climate emergency’ or ‘climate crisis’ instead. More generally, 2019 was a year when the rhetoric surrounding our climate system ramped up significantly, driven in part by the IPCC’s 2018 1.5°C report and the contributions by Greta Thunberg, who inspired a generation, and Extinction Rebellion. Other recent terminology includes the term ‘climate catastrophe’, introduced by Sir David Attenborough.

Do Tipping Points Exist?

Abrupt climate change is defined as a large-scale change in the climate system which takes place over a few decades or less and is anticipated to persist for at least a few decades and causes substantial disruption in human and natural systems. A number of components or phenomena within the Earth’s global or regional climate system have been proposed as potentially possessing critical thresholds, referred to as tipping points (see also Chapter 12), beyond which abrupt or nonlinear transitions to a different state ensues. Such a change is irreversible if the recovery time scale due to natural processes is significantly longer than the time it took to reach the new state. So, to some extent, it can be said that most aspects of climate change due to CO_2 emissions are irreversible due to the long residence time of CO_2 in the atmosphere.

Tipping point events may be irreversible and the term is usually used in the context of an irreversible change.



This is a map of potential tipping elements in the climate system, overlain on global population density. The subsystems indicated, including the cryosphere, the circulation of the atmospheres and oceans and biomes, could exhibit threshold-type behaviour in response to anthropogenic climate forcing, where a small perturbation at a critical point qualitatively alters the future fate of the system. They could be triggered this century and would undergo a qualitative change within this millennium. Systems in which any threshold appears inaccessible this century (e.g., East Antarctic Ice Sheet) or the qualitative change would appear beyond this millennium (e.g., marine methane hydrates) have not been included. Question marks indicate systems whose status as tipping elements are particularly uncertain.
Image reproduced with permission from Prof. Tim Lenton, University of Exeter from- Tipping elements in the Earth's climate system. PNAS 105*(6), 1786–1793, doi: 10.1073/pnas.0705414105.*

Another version of this diagram may be found at https://www.carbonbrief.org/explainer-nine-tipping-points-that-could-be-triggered-by-climate-change

Aspects of the Earth's climate system have tipped in the past and projections suggest that increasing greenhouse gas concentrations may lead to future tipping points being reached. The most likely abrupt, but reversible, change to the climate system expected in the 21st century is the decline of Arctic sea-ice, especially in the summer.

Change in climate system component	Potentially abrupt (AR5 definition)	Irreversibility if forcing reversed	Projected likelihood of 21st century change in scenarios considered
Atlantic MOC collapse	Yes	Unknown	*Very unlikely* that the AMOC will undergo a rapid transition (*high confidence*)
Ice sheet collapse	No	Irreversible for millennia	*Exceptionally unlikely* that either Greenland or West Antarctic Ice sheets will suffer near-complete disintegration (*high confidence*)
Permafrost carbon release	No	Irreversible for millennia	Possible that permafrost will become a net source of atmospheric greenhouse gases (*low confidence*)
Clathrate methane release	Yes	Irreversible for millennia	*Very unlikely* that methane from clathrates will undergo catastrophic release (*high confidence*)
Tropical forests dieback	Yes	Reversible within centuries	*Low confidence* in projections of the collapse of large areas of tropical forest
Boreal forests dieback	Yes	Reversible within centuries	*Low confidence* in projections of the collapse of large areas of boreal forest
Disappearance of summer Arctic sea ice	Yes	Reversible within years to decades	*Likely* that the Arctic Ocean becomes nearly ice-free in September before mid-century under high forcing scenarios such as RCP8.5 (*medium confidence*)
Long-term droughts	Yes	Reversible within years to decades	*Low confidence* in projections of changes in the frequency and duration of megadroughts
Monsoonal circulation	Yes	Reversible within years to decades	*Low confidence* in projections of a collapse in monsoon circulations

IPCC 2013 WG1 Table 12.4. Components in the Earth system that are potentially susceptible to abrupt or irreversible change.

Arctic Sea Ice

As the atmosphere and oceans warm, sea-ice melts which exposes a much darker ocean. This triggers a positive feedback by lowering the albedo of the ocean's surface and leading to more of the Sun's light being absorbed, amplifying the warming.

The rapidly declining summer Arctic sea-ice cover might already have passed a tipping point, although this is hard to identify due to high year-to-year variability. In this case, the Arctic will change from having year-round to seasonal sea-ice cover.

It is likely that the Arctic Ocean will become nearly ice-free in September before 2050 – although some ice may persist along northern coastlines. The transition will be abrupt but, if the amount of CO_2 in the atmosphere falls, the loss of sea-ice could be reversed within years to decades.

The effect of rapid changes to Arctic sea-ice might have consequences throughout the climate system, particularly on cloud cover.

The IPCC 1.5°C Report and 12 Years to Save the Planet

In late 2018, the Intergovernmental Panel on Climate Change published its Special Report on Global Warming of 1.5°C . The report highlighted a number of climate change impacts that could be avoided by limiting global warming to 1.5°C compared to 2°C, or more. For instance, by 2100, global sea level rise would be 10cm lower with global warming of 1.5°C compared with 2°C. The likelihood of an Arctic Ocean free of sea ice in summer would be once per century with global warming of 1.5°C, compared with at least once per decade with 2°C. Coral reefs would decline by 70-90% with global warming of 1.5°C, whereas virtually all (> 99%) would be lost with 2°C.

"Every extra bit of warming matters, especially since warming of 1.5°C or higher increases the risk associated with long-lasting or irreversible changes, such as the loss of some ecosystems". Allowing the global temperature to temporarily exceed or 'overshoot' 1.5°C would mean a greater reliance on techniques that remove CO_2 from the air to return global temperature to below 1.5°C by 2100. The effectiveness of such techniques are unproven at large scale and some may carry significant risks for sustainable development, the report notes.

"Limiting global warming to 1.5°C compared with 2°C would reduce challenging impacts on ecosystems, human health and well-being, making it easier to achieve the United Nations Sustainable Development Goals".

Although this was not stated in the IPCC's report, some media reported the findings of the report with headlines such as "we have 12 years to limit climate change" – a figure that was taken up by organisations around the world. It stemmed from the IPCC's conclusion that "limiting global warming to 1.5°C would require "rapid and far-reaching" transitions in land, energy, industry, buildings, transport, and cities. Global net human-caused emissions of carbon dioxide (CO_2) would need to fall by about 45% from 2010 levels by 2030, reaching 'net zero' around 2050." There are, however, many possible pathways to emissions reductions, and the 'final' temperature change depends on which is taken – do emissions fall gradually, or abruptly? Do they first carry on rising? When are reductions made?

Although such headlines did, arguably, generate a significant amount of attention and action, they can be less than helpful if they give rise to fear and a feeling of helplessness.

Greta Thunberg and Extinction Rebellion

Greta Thunberg started her School Strike for Climate in August 2018. By December, 20,000 students around the world had joined her. Extinction Rebellion was similarly formed in 2018.

Fridays for Future map of strikes: https://fridaysforfuture.org/statistics/map

Sources of Information

Intergovernmental Panel on Climate Change https://www.ipcc.ch
Carbon Brief https://www.carbonbrief.org/
Guardian https://www.theguardian.com/environment/climate-change and The Climate Crisis In 10 Charts