Climate Reality Check 2021

IMPACTS | RISKS | ACTIONS

20 critical understandings, observations & insights

BREAKTHROUGH
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Climate Reality Check 2021 draws together current climate research from around the world to present 20 critical observations, insights and understandings to help inform and guide the stark choices that now stand before us.

Climate Reality Check 2021 is a resource designed to help climate practitioners, advocates, journalists, business leaders and policymakers to better understand the alarming mismatch between the current climate risks and considerably inadequate level of climate action.

IMPACTS & RISKS

Analysis & assessment of threats

We have to move rapidly, what we do over the next three to four years, I believe, is going to determine the future of humanity.

PROFESSOR SIR DAVID KING
FORMER UK GOVERNMENT'S CHIEF SCIENTIFIC ADVISER

CURRENT IMPACTS

Warming is 1.2˚C and accelerating

#1

The rate of rise in global temperature is likely to speed up over the next 20-30 years

- The 2020 global temperature was 1.3˚C warmer than the late 19th century.
- The 5-year global average temperature for 2016-2020 was 1.2˚C, according to NASA[1] and Copernicus[2].
- Warming accelerated to ~0.25˚C for the most recent 2011-20 decade, compared to the average decadal rate of warming over the previous 50 years of 0.18˚C.
- Current (CMIP6) climate models project on average a warming of 0.3˚C for the decade to 2030 (across the SSP2-4.5, SSP3-7.0 and SSP5-8.5 scenarios).[3]
- The next 25 years are projected to warm at a rate of 0.25–0.35˚C per decade;[4] and there are warnings that the rate of global warming over the next 25 years could be double what it was in the previous 50 years.[5]

CURRENT IMPACTS

The IPCC and the climate models it relies upon do not capture all the risks

#2

There is a serious underestimation of future climate impacts

- Due to model limitations, we will not know exactly how the climate crisis will unfold until it's too late.[6] One example is the failure to predict the intensity of extreme heat and flood events in Europe and North America in 2021.[7]
- Current climate models are not capturing all the risks[8], including the stalling of the Gulf Stream[9], polar ice melt[10] and the uptick in extreme weather events. Carbon dioxide and methane release from deep permafrost are not routinely included in climate models.[11]
- Climate models do not account well for increased warming due to loss of Arctic sea-ice: "Losing the reflective power of Arctic sea ice will advance the 2°C threshold by 25 years."[12]
- The IPCC 2021 report gives "a best estimate of equilibrium climate sensitivity of 3˚C" but including factors such as "slow" feedbacks (carbon stores) and albedo changes (reflectivity), warming may be as high as 5–6˚C for a doubling of carbon dioxide for a range of climate states between glacial conditions and ice-free Antarctica.[13]

CURRENT IMPACTS

1.5˚C is not a safe target

#3

Vital ecosystems including the Great Barrier Reef are facing devastation now at well less than 1.5°C warming

- The Great Barrier Reef is in a death spiral: at the current level of global warming, it will bleach on average once every three-to-four years,[14] whereas recovery takes a decade or more.
- West Antarctic Ice Sheet (WAIS) glaciers have passed a tipping point,[15] and Greenland likely reached its tipping point 20 years ago.[16] The Paris Agreement temperature target of 1.5°C is sufficient to drive the runaway retreat of WAIS.[17]
- Parts of East Antarctica might be similarly unstable.[18]
- Three-quarters by volume of summer Arctic sea-ice has already been lost,[19] and it is in a death spiral.[20]
- One-quarter of the Himalayan[21] and Tien Shan[22] ice sheets have already been lost.
- The forest systems are oscillating to non-forest ecosystems in eastern, southern & central Amazonia.[23]

CURRENT IMPACTS

1.5˚C of warming is likely around 2030

#4

There is no carbon budget for the Paris goal

- Rising emissions, declining aerosols (air pollution) and natural climate cycles will contribute to faster warming,[24] as will greater stratification of the ocean with a hotter layer of water on top.[25]
- There is unanimity across the current (CMIP6) model simulations that warming will rise above 1.5˚C across all feasible scenarios "on average around 2030".[26]
- This is ten years earlier than previously forecast by the IPCC in 2018.
- There is likely no carbon budget for the climate Paris goal[27]: If carbon-cycle feedbacks are accounted for, "such as tipping points in forest ecosystems & abrupt permafrost thaw, the estimated remaining budget could disappear altogether".[28]
- Around 2030, with warming at 1.5˚C, and Arctic warming amplified to be three times the global average, the risk will grow substantially that Arctic carbon stores including permafrost[29] and boreal forests[30] will suffer significant, accelerating and unstoppable carbon losses.[31]

CURRENT IMPACTS

2°C is very dangerous and, on the current emission path, likely before 2050

#5

With further tipping points close at hand, 2˚C is a recipe for disaster

- On the current, higher-emission paths (SSP3-7.0 or SSP5-8.5) warming of 2˚C will be reached well before 2050, and on average around 2043 for these paths.[32]
- Further tipping points could be triggered at low levels of global warming: a cluster of abrupt shifts could occur between 1.5˚C and 2˚C.[33]
- These include the Greenland Ice Sheet, which is close to a tipping point,[34] previously estimated to be around 1.6˚C;[35] and the Amazon rainforest.[36]
- It is a big mistake to think we can "park" the Earth System at any given temperature rise – say 2˚C – and expect it to stay there.[37] 2˚C may not be a point of system stability.
- Former NASA climate chief Prof. James Hansen said that it is "well understood by the scientific community" that goals to limit human-made warming to 2˚C are "prescriptions for disaster".[38]

There is one thing I almost never hear leaders talk about, and that is loss and damage. For many of us, reducing and avoiding is not enough... You cannot adapt to extinction.

VANESSA NAKATE
UGANDAN CLIMATE ADVOCATE

CURRENT IMPACTS

No carbon budget for 2°C with a low risk of overshoot

6

Higher temperatures will result from greenhouse gases already in the atmosphere

- Earth energy imbalance (EEI) is the radiative imbalance at the top of the atmosphere (between outgoing and incoming radiation), which is driving global warming. The Earth is trapping nearly twice as much heat as it did in 2005.[39]
- In 2018 the EEI was 0.6–0.75˚C.[40] Added to the 1.2˚C of warming so far, expected warming is 1.8–1.95˚C for the current level of greenhouse gases.
- But emissions will not drop to zero tomorrow, and another 0.3˚C is projected over the next decade, regardless of the emissions path to 2030.
- If a prudent risk-management approach is taken — with attention given to the high-damage, high-end possibilities rather than middle-of-the-road probabilities — there is no carbon budget for the 2˚C target.[41]

CURRENT IMPACTS

A cascade of climate tipping points is unfurling

7

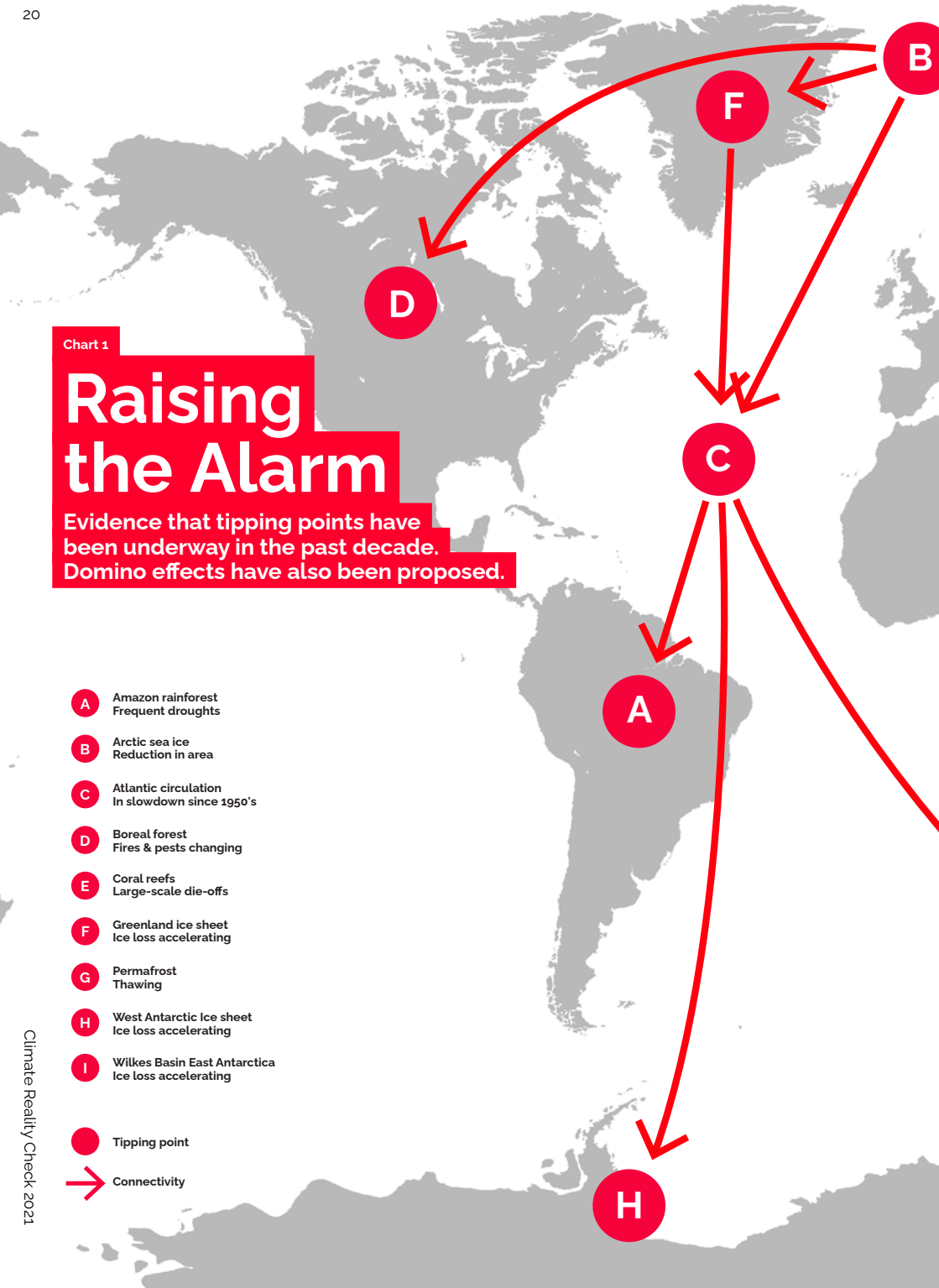
Some tipping points have been passed, others are close at hand

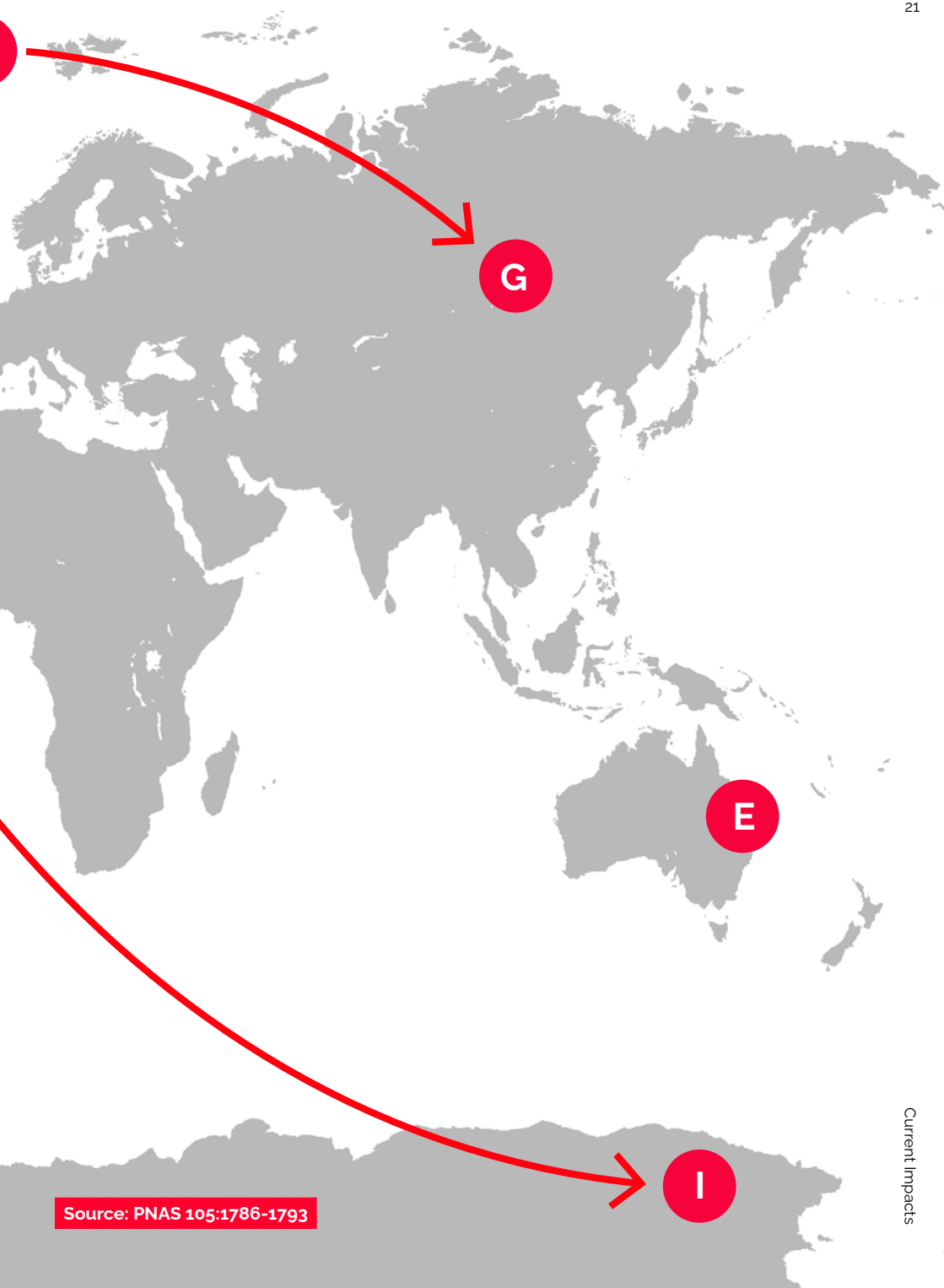
- A tipping point is a threshold beyond which large change will be initiated; positive feedbacks are self-reinforcing loops that will drive further change.
- Major tipping points are interrelated and may cascade,[42] as illustrated (see map on next page). Interactions between these climate systems could lower the critical temperature thresholds at which each tipping point is passed.[43]
- Warming ocean waters have caused a drop in Earth's brightness over the last two decades, so that less heat is being reflected and more absorbed. The effect is equivalent to approx. 0.3°C of additional warming.[44]
- Earth is approaching a temperature range above which photosynthesis rates decline and the storage of carbon in the terrestrial biosphere (the "land sink") falls. This tipping point lies within the next 20–30 years and, on a high emissions trajectory, a near halving of the land sink strength may result as early as 2040.[45]

Chart 1

Raising the Alarm

Evidence that tipping points have been underway in the past decade. Domino effects have also been proposed.





Source: PNAS 105:1786-1793

CURRENT IMPACTS

2˚C may trigger a “hothouse earth” scenario of self-reinforcing warming

8

We are perilously close to dramatic climate change that could run out of our control

- The "Hothouse Earth" scenario is one in which climate system feedbacks and their mutual interaction drive the Earth System climate to a point of no return, whereby further warming would become self-sustaining (that is, without further human perturbations).[46]
- This planetary threshold could exist at a temperature rise as low as 2°C, possibly even in the 1.5°C–2°C range.[47]
- In the physical interactions among the Greenland and West Antarctic ice sheets, the Atlantic Meridional Overturning Circulation and the Amazon rainforest, the polar sheets are often the initiators of cascade events[48], with Greenland and West Antarctica at risk of passing their tipping points within the 1.5°C–2°C Paris range (and there is evidence they have already done so).
- Similarly, Prof. James Hansen warned in 2007 that: "Recent greenhouse gas emissions place the Earth perilously close to dramatic climate change that could run out of our control."[49]

CURRENT IMPACTS

3˚C of warming would be catastrophic

9

The livelihoods of a billion people or more may be destroyed or severely impacted

- Unless emissions drastically decline this decade, there may be a decline in crop yields of 30% by 2050, whilst food demand will be 50% higher. The average proportion of global cropland affected by severe drought (greater than 50% yield reductions) will likely rise to 32% a year.[50]
- At 3˚C of warming, food production would be inadequate to feed the population due to a global average one-fifth decline in crop yields, a decline in nutrition content of crops, catastrophic decline in insect populations, desertification, monsoon failure and chronic water shortages.[51]
- 3˚C would be "catastrophic" for the livelihoods of the world's poorest three billion people, comprising mostly subsistence farmers, whose livelihood will be severely impacted, if not destroyed, with a one- to five-year megadrought, heat waves, or heavy floods.[52]

CURRENT IMPACTS

The world is on a 2–3.6°C warming path by 2100

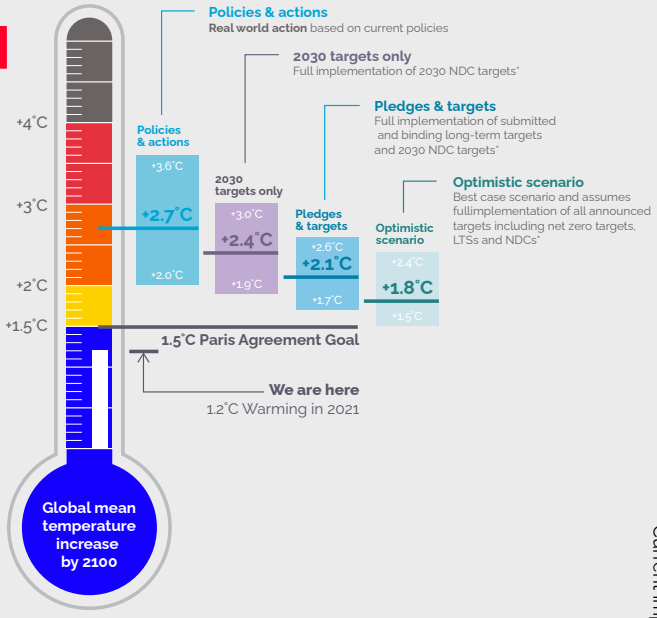
#10

We are heading towards levels of warming incompatible with an organised global community

- Global temperatures are on track for 2–3.6˚C of warming by 2100 with current policy commitments by governments, with a most likely figure of 3.4˚C (see diagram).
- Prof. Kevin Anderson says that "a 4˚C future is incompatible with an organised global community, is likely to be beyond 'adaptation', is devastating to the majority of ecosystems and has a high probability of not being stable".[53]
- Prof. Johan Rockström says that at 4˚C: "It's difficult to see how we could accommodate eight billion people or maybe even half of that."[54]
- The temperature increase is still on the high-emissions RCP8.5 path, and RCP8.5 is also the best match to mid-century under current and stated policies.[55]

Chart 2

CAT Warming projections Global tempreture increase by 2100



Source: climateactiontracker.org/global/cat-thermometer/

CURRENT IMPACTS

Sea levels will likely rise by tens of metres

#11

Current greenhouse gas levels risk a 25 metre rise in sea level

- Sea-levels will continue to rise over centuries, even when human greenhouse gas emissions cease, due to the long period (thermal inertia) over which ice sheets melt.
- US government agencies have a "high" sea-level rise scenario of 2.5 metres by 2100.[56]
- Sea levels will eventually rise by tens of metres: "Even if we curb all CO2 emissions today, and stabilise at the modern level, then our natural relationship suggests that sea level would continue to rise to about 25 metres."[57]
- During the Pliocene, 3–5 million years ago, when the CO2 level was similar to today, temperatures were 2–4˚C higher than pre-industrial and sea levels 20–25 metres higher.[58]
- "At that time, the indication is "that there [was] no Greenland ice sheet any more, no West Antarctic ice sheet and big chunks of East Antarctic [ice sheet] taken."[59]

CLIMATE IMPACTS

Reducing emissions alone will have no significant impact on warming trend over next two decades

#12

As fossil fuel use declines, so will aerosol emissions, which have been offsetting some warming

- A by-product of burning fossil fuels are sulfate aerosols, which have a strong cooling impact of 0.5–1˚C, but are short-lived in the atmosphere. Aerosols have been "masking" some of the warming so far.[60]
- Declining coal use and clean air policies reduce the aerosol impact. This is our "Faustian bargain"[61] as fossil fuel use declines, so does the aerosol cooling, so that for the next two decades lower emissions will have little impact on the warming trend.
- A 5% annual reduction in emissions of a single greenhouse gas, from 2020 and based on a middle-road emissions path, has no statistically significant effect on warming for more than two decades, as compared to a no-mitigation pathway (see Table).[62]
- Nevertheless, fast emission cuts are vital to flatten the warming curve.

Table 1
Emergence years with 5% annual emissions reductions from 2020*

Carbon dioxide	2044
Methane	2055
Nitrous oxide	2079
Black carbon	2048
Organic carbon	2064

Source: Nature Communications 112:3261, table 3

* Year of emergence, after mitigation of one climate forcing component from 2020, defined as the year when half or more of the ensemble members are significantly different from the baseline (RCP4.5) according to a Student's t-test.

MAJOR RISKS

Understanding the urgency

If we go beyond 2°C it's very likely that we have caused so many tipping points that you have probably added another degree just through self-reinforcing changes... The moment that the Earth system flips over from being self-cooling— which it still is — to self-warming, that is the moment that we lose control.

PROFESSOR JOHAN ROCKSTRÖM
DIRECTOR, POTSDAM INSTITUTE FOR CLIMATE IMPACT RESEARCH

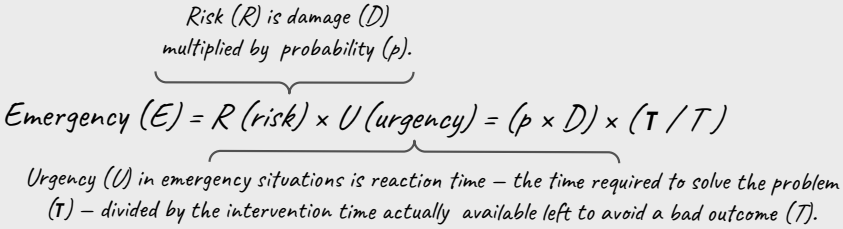
MAJOR RISKS

The risks are existential

#13

We are in a state of planetary emergency: the risk and urgency are acute

- In 2019 scientists offered a climate emergency formula.[63] Generally, risk is considered to be the potential damage multiplied by the probability, but in this equation, another element is added, called urgency. This is the relationship between:
  - the reaction time "τ" (how long it takes to solve a problem); and
  - the intervention time "T" (the time you actually have, before it is "too late").
- Think of the Titanic: "If reaction time is longer than the intervention time left ("τ" / T > 1), we have lost control."[64]
- "The evidence from tipping points alone suggests that we are in a state of planetary emergency: both the risk and urgency of the situation are acute… If damaging tipping cascades can occur and a global tipping point cannot be ruled out, then this is an existential threat to civilization."[65]



MAJOR RISKS

The risks are existential for nature, too

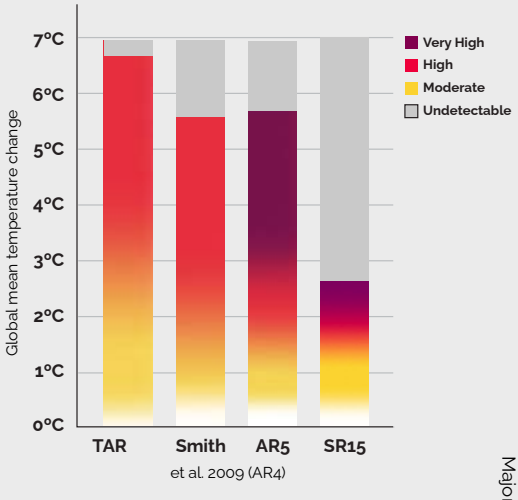
#14

We are now entering the sixth mass extinction in Earth's history

- The rate of change matters. Many ecosystems (such as Arctic, corals, dry subtropics) have not adapted to 1˚C change in a century (0.1˚C/decade).
- Warming for the 2010-2019 decade was 0.25˚C, and is projected to be higher in the next 2–3 decades. (#1)
- We are now entering the sixth mass extinction in Earth's history.[66]
- At warming of 3.5˚C by 2100 (rate of 0.3˚C/decade), only 30% of all impacted ecosystems can adapt and only 17% of all impacted forests can adapt.[67] Common tree species cannot adapt naturally by poleward shifts to >2˚C per century.
- The "burning embers" diagram from the 2018 IPCC special report SR15 shows "very high risk" with limited ability for unique and threatened ecosystems to adapt to 2˚C of warming (see diagram)

Chart 3

Unique & threatened ecosystems



IPCC Special Report 1.5˚C

MAJOR RISKS

Sensible risk-management requires special attention be given to high-end possibilities

#15

Precautionary action is necessary to prevent existential outcomes

- An emergency exists if the world is approaching a global cascade of tipping points that leads to a "hothouse" climate state: "Cascading effects might be common… examples are starting to be observed."[68]
- Climate change is an existential risk to human civilisation (contemporary society).[69]
- This requires special precautions beyond conventional risk management practice if the increased likelihood of "fat tail" (high end) risks are to be adequately dealt with.
- Calculating probabilities makes little sense in the most critical instances. Rather, we should identify and focus on the very large climate impact, "fat tail", possibilities.[70]
- And then take precautionary action to prevent them occurring.

CRITICAL ACTIONS

Key responses for protection

We are literally in a climate emergency, and... We are increasingly hearing that this is the fight of our lives.

PATRICIA ESPINOSA
UNFCCC EXECUTIVE SECRETARY

CRITICAL ACTIONS

Zero emissions at emergency speed: 2030 — not 2050 — is the crucial time frame

#16

Long-term targets are an excuse for procrastination

- It is already too hot and we are dangerously close to the "Hothouse Earth" scenario, yet *current* greenhouse gas levels may be enough to cause 2–4˚C of warming in the longer term.
- The primary task is to build capacity for emergency speed and scale emissions elimination, and to minimise the rate and magnitude of warming.
- Mobilising for zero emissions by 2030 is critical.
- A 2050 timeframe will not prevent catastrophic outcomes.
- Long-term targets are an excuse for procrastination. That has been the history of international climate policy-making.

CRITICAL ACTIONS

The earth is already too hot: large-scale drawdown is vital

#17

Removing greenhouse gases from the atmosphere can cool an overheated Earth

- Stabilisation (at the current temperature) would require carbon drawdown of 60 ppm (back to ~350 ppm) to stop further warming of ~0.7˚C. Lowering current warming would require additional drawdown.[71]
- CO2 may be drawn out of the atmosphere by natural cycles on land (by reforestation, for example) and in oceans, by rock weathering and by storage in soils.[72]
- These processes can be enhanced, and new technologies are being developed. Large-scale research and deployment is crucial.
- Drawdown is a slow process that will not result in any cooling until it is greater than the level of emissions.
- We should be wary of relying on claims that in the distant future bioenergy with carbon capture and storage (BECCS) is a panacea.[73]

CRITICAL ACTIONS

A safe means of near-term cooling is critical to protect people & nature

#18

Damage is — and will become more — dangerous before long-term solutions are effective

- Warming is already dangerous, likely to reach 1.5˚C by 2030, 2˚C before 2050 and 2.5–4.7˚C by 2100 on the current path, bringing unacceptable risks of a "Hothouse Earth" scenario.
- Mitigation is vital but by itself will not have noticeable beneficial impact on temperature trajectory until the mid-2040s.
- This delay in mitigation effect may trigger further significant physical tipping points.
- Zero emissions, even in a decade, coupled with large-scale drawdown, is not sufficient to negate the existential risk.

Can near-term cooling be of net environmental and social benefit?

- We need options to cool the planet and/or protect vital climate systems, particularly in the polar regions. Options for polar cooling include enhancing the capacity of marine clouds to reflect incoming radiation.
- Solar radiation management (SRM), using cooling aerosols, can have a strong, immediate cooling effect.
- There is no current evidence that SRM would demonstrate a net environmental and social benefit but, if proven, it may be considered an interim cooling measure whilst longer-acting solutions are deployed and take effect.[74]
- Sound local and global SRM governance would be required to navigate the associated issues and risks in order to prevent unilateral deployment by national actors and misuse.[75]

CRITICAL ACTIONS

Adaptation actions should protect the most vulnerable

#19

Adaptation should be applied to unavoidable circumstances, but should not be substituted for deep climate prevention and restoration

- Adaptation should be seen as a parallel strategy to mitigation to deal with unavoidable impacts and risks.
- It is no substitute for deep climate mitigation and restoration because it is not possible for most people and nature to adapt to 3–5˚C of warming this century.
- There is the danger of the "adaptation trap", where most effort is put into adaptation, and the lack of adequate mitigation delivers a "hothouse Earth".
- Adaptation should prioritise actions to protect the most vulnerable human populations and nature.
- We should strengthen the capacity and skills required by people to face climate disruption with honesty, courage and compassion.

CRITICAL ACTIONS

The collapse of civilisation is not inevitable, but emergency-level action right now is critical

#20

An emergency response would make climate the number one priority of politics and economics

- Many human and Earth systems are increasingly fragile.
- The end of civilisation due to climate disruption — the generalised collapse of contemporary societies — is not certain or inevitable.
- But it is likely unless dramatic global action is taken to make climate the number one priority of economics and politics in an emergency response.
- Large-scale disruption is inevitable, either by failing to act fast enough, or because the scale of action now required is far beyond a gradualist approach.
- The short term is crucial: what we do now and before 2030 matters, not aspirations about 2050.

SUMMARY

Key points

KEY IMPACTS

- 1.5˚C temperature around or before 2030, irrespective of actions taken in the interim.
- 2˚C is likely prior to 2050, even with actions better than the current emission reduction commitments, 3˚C in the second half of the century, with 5˚C possible before 2100.
- Even substantial emission reductions will have no significant impact on the warming trend over the next 20-25 years, due to the offsetting effect of aerosols.
- The current 1.2˚C of warming is already dangerous; 2˚C would be extremely dangerous; 3˚C catastrophic; and 4˚C unliveable for most people.
- A "Hothouse Earth", non-linear, irreversible, self-sustaining warming may be triggered between 1.5–2˚C. There is a risk that we have already lost the ability to prevent accelerating warming.

RESPONSES & ACTIONS

Societies that are successfully overcoming the Covid pandemic threat are doing so by making it the highest priority of politics and economics, based upon acceptance of the best available science. Climate is a much bigger threat, that requires the same approach.

- Assess the real risks with brutal, rigorous honesty.
- Recognise that climate disruption requires an emergency, planned response.
- Act fast for zero emissions by 2030.
- Build capacity for large scale drawdown of greenhouse gases.
- Understand what role near-term cooling methods may play if proven safe.
- Making action on climate disruption a first priority of government is the key to protecting people, society and nature.

FOOTNOTES

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