Climate Reality Check 2020

IMPACTS | RISKS | ACTIONS

20 critical understandings,
observations & insights

Climate Reality Check 2020 draws together current climate science 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.

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CURRENT IMPACTS

What's the latest climate analysis & assessment?

MAJOR RISKS

How can we think about major threats to society?

CRITICAL ACTION

What does this mean for climate action in 2020?

SUMMARY

Overview
Science & Action

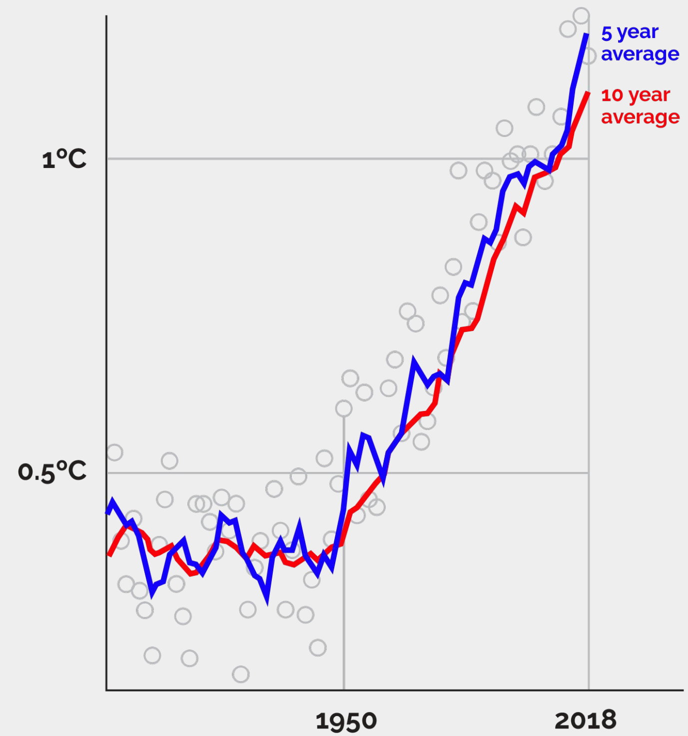
CURRENT IMPACTS

What's the latest climate analysis & assessment?

#1 Warming is approaching 1.2˚C and accelerating

- Five-year global average temperature for 2015-2019 was 1.16˚C above late 19thC baseline.[1]
- Two of the last four years have been ≥ 1.2˚C.
- Warming has accelerated to ~0.25˚C for the most recent 2010-19 decade.[2]
- The next 25 years are projected to warm at a rate of 0.25–0.35˚C per decade.[3]

Rise in global average temperature above 1880-1899 baseline

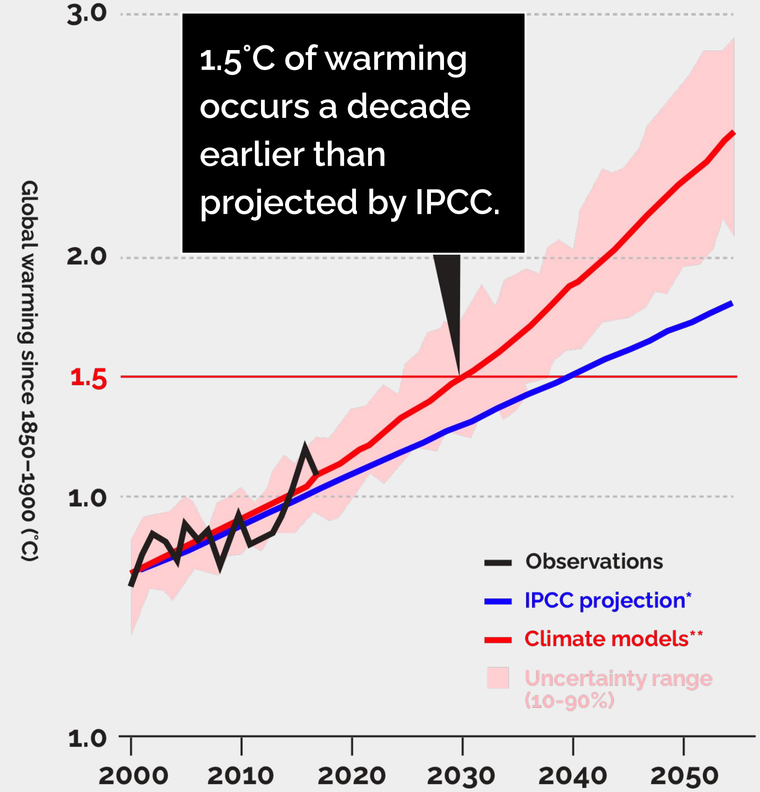


Source: Berkeley Earth

#2 1.5˚C warming is likely by 2030, even earlier

- Many research papers project warming to reach 1.5˚C around 2030, or sooner.[1]
- A comparison of results from the latest generation of climate models suggest 1.5˚C may be only five-to-seven years away (see table #5).[2]
- Reaching 1.5˚C by 2030 would be a decade ahead of IPCC projections.[3]

1.5˚C a decade ahead of IPCC projections



* Trend for 2001–15 extended with a constant rate of 0.2˚C per decade, as per IPCC special report.
** Ten-year average, 37 climate models for the RCP8.5 scenario (IPCC Fifth Assessment, 2014).

Source: *Nature* 564:30-32

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

- A by-product of burning fossil fuels are sulfate aerosols, which have a strong cooling impact, but are short-lived in the atmosphere. Aerosols have been "masking" some of the warming so far.[1]
- Declining coal use and clean air policies reduce the aerosol impact. This is our "Faustian bargain".[2]
- 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).[1]
- Nevertheless, fast emission cuts are vital to flatten the warming curve.

Emergence years with 5% annual emissions reductions from 2020[2]	
Carbon dioxide	2044
Methane	2055
Nitrous oxide	2079
Black carbon	2048
Organic carbon	2064

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.

Source: *Nature Commmunications* 11:3261, table 3.

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1.75–2.4˚C of warming for current greenhouse gas levels

- Earth's energy imbalance (EEI) is the difference between amount of solar energy absorbed by Earth and amount of energy the planet radiates to space as heat. If the imbalance is positive (more energy coming in than going out), we can expect Earth to become warmer in the future.
- Current EEI is 0.6–0.75˚C.[1] Added to 1.15–1.2˚C of warming so far, expected warming is 1.75–1.95˚C for the current level of greenhouse gases.
- The total theoretical warming if the current level of greenhouse gases (~490 ppm CO_2e)[2] were maintained in longer term is ~2.4˚C at equilibrium.[3]

If a prudent risk-management approach is taken — with attention given to the high-end possibilities rather than middle of the road probabilities — there is no carbon budget for the 2°C target.[4]

#5

On current path, 2°C well before 2050

- A comparison of current climate models show the median year in which warming thresholds of 1.5°C, 2°C, 3°C, 4°C and 5°C are reached for three emissions trajectories: low, central and high (see table).[1]
- Using the MAGIC model, the timings of key temperatures of 1.5°C, 2°C, 2.5°C and 3°C are illustrated with coloured dots for various emission paths (see chart).[2]

Warming scenarios

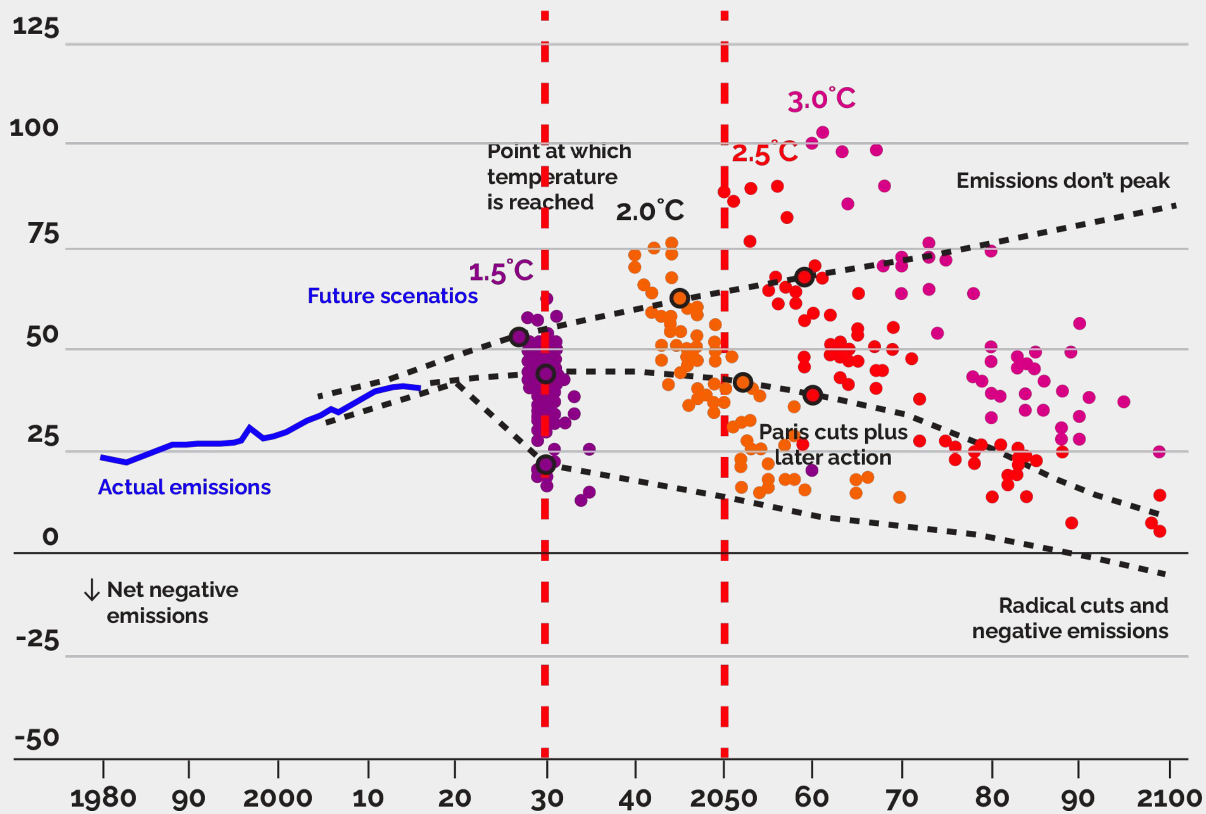
	Low	Central	High
1.5°C	2026	2027	2025
2°C	2058	**2044**	**2038**
3°C	n/a	2090	2059
4°C	n/a	n/a	2076
5°C	n/a	n/a	2094

Climate model projections from Scenario Model Intercomparison Project of CMIP6

Source: Tebaldi et al., 2020, *Earth System Dynamics*, 16 September, pre-print, table A7.

- The emissions path has little impact on timing of the 1.5˚C threshold ~2030.
- 2˚C reached before 2050 for both the high and central emission scenarios.
- With high emissions scenario, 3˚C may be reached ~2060 and 5˚ C before 2100.

Scenarios for future CO_2 emissions with three representative pathways picked out



Source: Glen Peters chart from GCP, CDIAC data

#6 The picture painted by the IPCC is too conservative

- Climate models used for projecting future warming and calculating carbon budgets in past IPCC reports estimate a warming sensitivity of ~3˚C (for doubled CO_2).
- Including "slow" feedbacks (e.g. permafrost) and albedo changes , warming may be as high as 5–6˚C for a doubling of CO_2 for a range of climate states between glacial conditions and ice-free Antarctica.[1]
- Future warming is likely to be 15% higher (~0.5˚C) for high scenarios by 2100 compared to raw climate model projections reported so far by the IPCC.[2]
- 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."[3]

#7 1.5˚C is not safe

- The Great Barrier Reef is in a death spiral: at current level of warming it will bleach on average about once every three-to-four years,[1] whereas recovery takes a decade or more.
- West Antarctic glaciers have passed a tipping point.[2] Paris Agreement temperature target of 1.5˚C is sufficient to drive runaway retreat of West Antarctic Ice Sheet.[3]
- Parts of East Antarctica might be similarly unstable.[4]
- Three-quarters by volume of summer Arctic sea-ice has already been lost.[5]
- One-quarter of the Himalayan & Tien Shan ice sheets already lost.[6]
- Forest system oscillating to non-forest ecosystems in eastern, southern & central Amazonia.[7]

Melting Antarctic ice will raise sea level by 2.5 metres – even if Paris climate goals are met, study finds

The Guardian, 24 September 2020

#8 2°C is very dangerous

- 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 (#10).[1]
- These include the Greenland Ice Sheet, which is close to a tipping point,[2] previously estimated to be around 1.6˚ C;[3] and the Amazon rainforest.[4]
- 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. 2˚C may not be a point of system stability.[5]
- 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".[6]

9 The world is on a 3–5˚C warming path by 2100

- Global temperatures are on track for 3–5˚C of warming by 2100.[1]
- 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.[2]
- 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".[3]
- 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."[4]


Global temperatures on track for 3-5 degree rise by 2100: U.N.

By Reuters Staff

(Reuters) - Global temperatures are on course for a 3-5 degrees Celsius

#10

2°C may trigger a "hothouse Earth" scenario of self-reinforcing warming

- The "Hothouse Earth" scenario is one in which system feedbacks and their mutual interaction drive the Earth System climate to a "point of no return", whereby further warming would become self-sustaining (without further human perturbations).[1]
- This planetary threshold could exist at a temperature rise as low as 2°C, possibly even in the 1.5°C–2°C range.[2]
- 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."[3]

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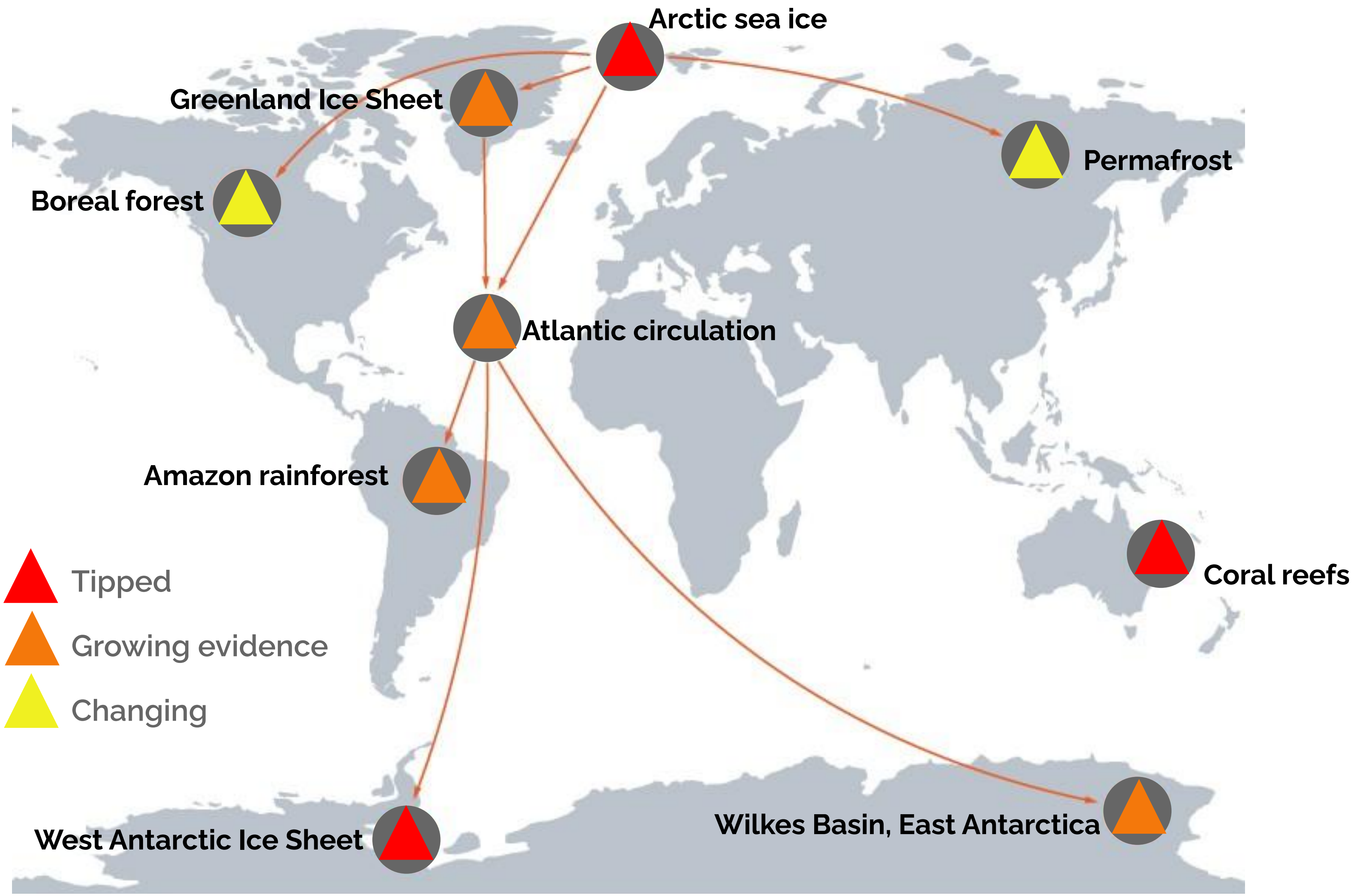
Hothouse Earth paper impactful climate research article & German word of the year of 2018

#11 3°C of warming would be catastrophic

- At 3°C of warming, food production would be inadequate to feed 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.[1]
- 3°C would be "catastrophic" for livelihoods of the world's poorest three billion people, living mostly in tropical rural areas.[2]
- "Even if we curb all CO_2 emissions today, and stabilise at the modern level, then our natural relationship suggests that sea level would continue to rise to about 25 metres."[3]

Climate Tipping Points



Adapted from *PNAS* 105:1786-1793

12 Climate history previews our hot future

- During the Pliocene, 3–5 million years ago, when the CO_2 level was similar to today, temperatures were 2–4˚C higher than pre-industrial and sea levels 20–25 metres higher.[1]
- "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."[2]
- During the Pliocene, there were trees at the South Pole. "I call them the last forests of Antarctica. They were growing at 400 ppm CO_2, so this may be where we are going back to with ice sheets melting at times, which may allow plants to colonise again" (Jane Francis, director of the British Antarctic Survey).[3]

MAJOR RISKS

How can we think about major threats to society?

#13 The risks are existential

In 2019 scientists offered an emergency formula.[1] 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.”[2]

Risk (R) is damage (D) multiplied by probability (p).

$$\text{Emergency } (E) = R \text{ (risk)} \times U \text{ (urgency)} = (p \times D) \times (\tau / T)$$

Urgency (U) in emergency situations is reaction time – the time required to solve the problem (τ) – divided by the intervention time actually available left to avoid a bad outcome (T).

"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."

— LENTON, ROCKSTRÖM, GAFFNEY, RAHMSTORF, RICHARDSON, STEFFEN & SCHELLNHUBER 'CLIMATE TIPPING POINTS — TOO RISKY TO BET AGAINST'[1]

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The risks are existential for nature, too

- The rate of change matters. Many ecosystems (e.g. Arctic, corals, dry subtropics) have not adapted to 1˚C change in a century (0.1˚C/decade).
- The “burning embers” diagram from IPCC special report SR15 shows “very high risk” with limited ability for unique and threatened ecosystems to adapt to 2˚C of warming.
- Warming for 2010-2019 decade was >0.25˚C, and projected to be higher in next 2-3 decades (#2).
- 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 likely to adapt.[1] Common tree species cannot adapt naturally to > 2˚C per century by poleward shifts.
- We are now entering the sixth mass extinction in Earth’s history.[2]

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

- 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."[1]
- 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*.[2]
- Climate change is an existential risk to human civilisation (contemporary society).[3]

Fundamental questions about risk

1. How close are we to losing control? Is there a non-trivial probability that we "might already have lost control of whether tipping happens", that the reaction time required to solve the problem (*τ*) is greater than the intervention time actually left to avoid a bad outcome (*T*)?
2. How large is that emergency/existential risk?
3. Can the reaction time required to solve the problem and apply the solutions be reduced, for example from 2050 to 2030? How could this be done?
4. Can the intervention time available to avoid catastrophe be extended? How can the rate of warming be slowed and the Earth cooled?

CRITICAL ACTIONS

What does this mean for climate action in 2020?

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

- 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 (#12).
- 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.

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

- Stabilisation (at current climate) would require carbon drawdown of 60 ppm (back to ~350 ppm) to stops further warming of ~0.7˚C.[1] Lowering current warming would require more drawdown.
- CO_2 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.[2]
- These processes can be enhanced, and new technologies are being developed. Large-scale research & deployment is crucial.
- Drawdown is slow process: will not provide cooling until drawdown annually > emissions annually.
- We should be wary of relying on claims that in the distant future bio-energy with carbon capture and storage (BECCS) is a panacea.[3]

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

1. Warming is already dangerous, likely to reach 1.5˚C by 2030 (#2), 2˚C before 2050 (#5) and 3–5˚C by 2100 on the current path (#9).
2. This will trigger more large system tipping points and brings unacceptable risks of a "Hothouse Earth" scenario (#10).
3. Mitigation is vital but will not have noticeable beneficial impact on temperature trajectory till mid-2040s due to concurrent aerosol loss (#3).
4. This delay in mitigation effect may trigger further significant physical tipping points.

#18 A safe means of immediate cooling is critical to protect people & nature

- Zero emissions, even in a decade, coupled with large-scale drawdown, is not sufficient to negate the existential risk (#13).
- Solar radiation management (SRM), such as deployment of cooling aerosols in upper atmosphere, 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.[1]
- There are global SRM governance issues and risks to navigate in order to prevent unilateral deployment by national actors and misuse.[2]

#19 Adaptation actions should protect the most vulnerable

- 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 & 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.

#20 Collapse of civilization is not inevitable, but emergency-level action right now is critical

- Human & 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: Science

1. 1.5˚C temperature around or before 2030, irrespective of actions taken in the interim, and a decade ahead of IPCC projections.
2. 2˚C is likely prior to 2050, even with actions better than the current Paris Agreement commitments, 3˚C in the early-to-mid second half of the century on current emissions trajectory, with 5˚C possible before 2100.
3. 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.
4. The current 1.2˚C of warming is already dangerous; 2˚C would be extremely dangerous; 3˚C catastrophic; and 4˚C unlivable for most people.
5. 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.

Summary: 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.

1. Assess the real risks with brutal, rigorous honesty.
2. Recognise that climate disruption requires an emergency response and plan.
3. Act fast for zero emissions by 2030.
4. Build capacity to draw down carbon.
5. Understand what role solar radiation management may play.

Making action on climate disruption the highest priority of government is the key to protecting people, society and nature.

BREAKTHROUGH

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