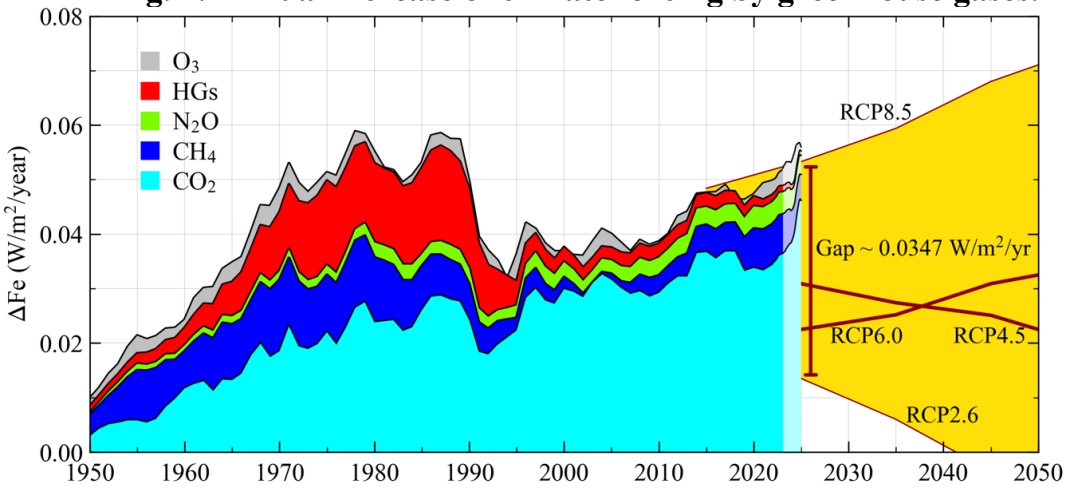
Fig. 1. Annual increase of climate forcing by greenhouse gases.



Warning! This "Colorful Chart" is Censored by IPCC

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Abstract. The growth rate of greenhouse gas (GHG) climate forcing increased rapidly in the last 15 years to about 0.5 W/m^2 per decade, as shown by the "colorful chart" for GHG climate forcing that we have been publishing for 25 years (Fig. 1).[1] The chart is not in IPCC reports, perhaps because it reveals inconvenient facts. Although growth of GHG climate forcing declined rapidly after the 1987 Montreal Protocol, other opportunities to decrease climate forcing were missed. If policymakers do not appreciate the significance of present data on changing climate forcings, we scientists must share the blame.

Our approach to climate analysis places highest priority on data. Climate forcing (see the definition at the end of this communication) by GHGs is a good place to start, as it is the drive for global warming. GHG amounts are well-measured. Our calculated forcings are in close agreement[2] with those of IPCC and we also agree with IPCC that the uncertainty in absolute GHG forcing is about 10%.[3] We show the 60-month (5-year) running-mean of GHG forcing change (Fig. 1) to smooth out short-term variability of sources and sinks of the gases. Thus, results for the last 2.5 years are shaded, because they are <60-month means and will therefore change as more data are added, likely decreasing the current peak value a bit. [HGs are 45 halogenated gases, including the HGs covered by the Montreal Protocol and other HGs.]

One implication of the increased growth rate of GHG forcing in the last 15 years is that the goal to keep global warming under 2°C is now implausible. IPCC defined a GHG scenario (RCP2.6) intended to provide a 66% chance of keeping global warming below 2°C. Actual growth of GHG forcing has diverged dramatically from that scenario (Fig. 1), with reality being close to the extreme RCP8.5 scenario. The gap between reality and RCP2.6 could be closed by capturing and storing CO_2 (carbon capture and sequestration, CCS), but the *annual* cost for the gap at January 2023 (the time of the last 60-month mean) would be $2.4-5 trillion[4] with current technology, and the gap and annual cost are increasing.

RCP2.6, in fact, was never plausible, as it relied on assumption of large-scale biomass-burning at powerplants with carbon capture and permanent storage of the captured CO_2, a scheme that

would ravage nature and threaten food security.[5] We scientists must share the blame, if we allow policymakers to believe that such scenarios provide a realistic projection of climate change.

Missed opportunities to phase down the growth of GHGs are worth understanding because that knowledge can aid development of future policies. Useful information on climate change and energy policy was already available in 1988, when IPCC was formed. Global reserves of conventional fossil fuels (coal, oil, gas) clearly were enough to cause climate change, albeit of uncertain magnitude. The science community had been asked, at least implicitly, if it made sense to develop unconventional fossil fuels to succeed coal, oil, and gas as a major source of world energy. The famous Charney report[6] on climate change was requested by the Science Adviser of U.S. President Jimmy Carter because of concern about potential climate effects of Carter's plans for coal gasification and the fossil fuel industry's budding efforts in hydrofracturing of rock formations (fracking) to extract "tight" oil and gas. In subsequent decades, scientific concern about the threat of human-caused climate change grew continually.

Given a desire to limit fossil fuel emissions, economics recognizes superiority of honest pricing as the efficient means to achieve change, as opposed to arbitrary political dictates. The price of fossil fuels should include their costs to society, which implies the merit of a slowly rising carbon fee to achieve competition among clean energies, energy efficiency, and carbon capture. Instead, the 1997 Kyoto Protocol and 2015 Paris Agreement are precatory (wishful thinking) agreements to try to reduce future emissions. The Paris meeting was preceded by substantial effort to inform the delegates about the need for a simple, honest, rising, carbon fee, but the response of the Executive Secretary of the United Nations Framework Convention on Climate Change dismissed this with "(Many have said) we need a carbon price and (investment) would be so much easier with a carbon price, but life is more complex than that."[7] In fact, a carbon price is the simple approach; it only requires agreement of the nations with largest emissions; it can be made near-global by border duties on products from nations without a carbon price. The reason a global carbon price does not exist is that governments are under the corrupting thumb of special interests and give little weight to the interests of young people and future generations.

A second missed opportunity, although less fundamental than the failure to promote a carbon fee or tax, is egregious because it was self-inflicted by the COP (Conference of the Parties) process. In 2001 at COP 6-2 in Bonn, Germany used its position as host nation to push through exclusion of nuclear power from support as a Clean Development Mechanism (CDM). Indeed, failure to support development of nuclear power as a carbon-free source of energy was widespread. In President Bill Clinton's first State-of-the-Union speech after the 1992 United States election, he announced that research and development of nuclear power was unnecessary and would be terminated. Almost unlimited subsidy of renewable energies was adopted in many U.S. states and some other nations via "Renewable Portfolio Standards," requiring utilities to obtain a growing fraction of their energy from renewable energies. This approach, as contrasted with "Clean Energy Portfolio Standards," spurred the development of natural gas as the complement to intermittent renewable energy, and, as a consequence, expansion of fracking, pipelines, and methane leakage. Nuclear power, given the costs of the fuel and materials to build a power plant, has potential to be the least expensive among the firm, dispatchable, energy sources, but attainment of its potential, as with other sources, requires extensive R&D and experience. Thus, it is ironic that the COP now suddenly asks for nuclear energy output to be tripled.[8]

How effective is IPCC? Is IPCC expected to be a source of scientific advice for the United Nations? If so, how is it that the Secretary General continues to assert that it is still feasible to keep global warming from exceeding the 1.5°C limit?

Does IPCC operate under the rules of science? We ask because the paper Ice melt, sea level rise and superstorms: evidence from paleoclimate data, climate modeling, and modern observations that 2 C global warming could be dangerous,[9] which we submitted and published a decade ago, is not mentioned in the most recent (2021) IPCC assessment report (AR6).[10] Our *Ice Melt* paper addresses the objective of the United Nations Framework Convention on Climate Change,[11] to "…prevent dangerous anthropogenic interference with the climate system," concluding that continued high GHG emissions are likely to cause shutdown of the AMOC (Atlantic Meridional Overturning Circulation) near mid-century and multi-meter sea level rise on the century time-scale, conclusions that strongly conflict with IPCC's AR6 assessment. Our paper – because of its strong conclusions – faced and passed extensive peer-review. IPCC seems to believe that it has been granted special powers and does not need to follow the scientific method.

Does IPCC explain the core issues in a transparent fashion, understandable to policymakers? Despite great progress in clean energy development (solar, wind, geothermal), global warming has accelerated, as the growth rate of the human-made climate forcing is increasing, not declining (Fig. 1). The changing drive for climate change exposed by the colorful diagram – climate forcing caused by greenhouse gas (GHG) changes – is only part of the story, but it is the most important part and deserves greater exposure. However, IPCC's method for projecting future GHG forcing – "integrated assessment models (IAMs)" that produce the RCP scenarios – are dark boxes. We must, and will, produce more transparent projections that are more clearly related to feasible policy choices.

Policy choices in the next 5-10 years will be crucial for determining the world that today's young people and their children will live in. Although that was also true 10 years ago and 20 years ago, the situation is different now. Now we are well into the period of consequences and now the danger of passing the global irreversible point-of-no-return has increased markedly.

The present global approach for addressing climate change is not only ineffectual wishful-thinking, it is irresponsible. Phasedown of GHG emissions requires effective policies on decadal time scales, not mid-century targets that permit obfuscation of the absence of effective policy.

Reassessment of the climate change situation requires quantification of policy alternatives. Reassessment must be based on the scientific method.

Note: the link to our last communication, which did not work for some people, is now on YouTube at A Climate Talk in Helsinki

Definition: a climate forcing is an imposed perturbation of Earth's energy balance. For example, if the brightness of the Sun increased 2%, that would be an effective climate forcing of about +4 W/m^2, where W/m^2 is watts per square meter averaged over Earth's surface. The forcing caused by doubling the amount of carbon dioxide (CO_2) in Earth's atmosphere is also about +4 W/m^2, because the added CO_2 reduces Earth's heat radiation to space by about 4 W/m^2.

The net human-made climate forcing is probably about +2.5-3 W/m^2, because human-made aerosols (fine airborne particles) increase reflection of sunlight to space by an amount that is not well-measured, but is probably[12] 1-1.5 W/m^2.

Earth responds to this energy imbalance (more energy coming in than going out) by warming. Warming continues until Earth is radiating to space as much energy as it is absorbing from the Sun, and thus equilibrium (energy balance) is restored. Because of the large heat capacity of the ocean, it takes a long time to approach a new equilibrium. Today, Earth is still out of energy balance by about +1 W/m^2, so there is still substantial warming "in the pipeline," even without further increase of atmospheric greenhouse gases (GHGs).

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[1] Hansen JE, Sato M, Trends of measured climate forcing agents, *Proc. Natl. Acad. Sci.* **98 (26)**, 14778-83, 2001

[2] IPCC defines a forcing, ERF, that excludes the second term of Equation (3) in our *Pipeline* paper (the next reference, below), which thus yields forcings that average several percent smaller than our effective forcings, Fe. When that second term is included, the IPCC total GHG forcing is in close agreement with ours; for some individual gases there are differences of several percent. Comparisons are included in the *Pipeline* paper. For updates of ozone forcing beyond the IPCC AR6 report and minor HGs that are not reported by NOAA, we use annual reports of P.M. Forster et al., https://essd.copernicus.org/articles/17/2641/2025/ *Earth Syst. Sci. Data* 16 (2024): 2625–58 https://doi.org/10.5194/essd-16-2625-2024-supplement

[3] Hansen JE, Sato M, Simons L *et al*., "Global warming in the pipeline," *Oxford Open Clim. Chan.* **3 (1)**, 2023

[4] Assuming empirical cost estimates of $451-924 Trillion US$/tC, based on a pilot direct-air CO_2 capture plant. See J. Hansen, P. Kharecha, "Cost of carbon capture: Can young people bear the burden?" *Joule* **2**, 1405-7, 2018

[5] Creutzig F, Erb KH, Haberl H *et al*. Considering sustainability thresholds for BECCS in IPCC and biodiversity assessments. *GCB Bioemergy* 2021;**13**:510-5

[6] Charney J, Arakawa A, Baker D *et al*. *Carbon Dioxide and Climate: A Scientific Assessment*. Washington: National Academy of Sciences Press, 1979

[7] Hansen J, Isolation of 1600 Pennsylvania Avenue: Part I, 27 November 2015

[8] United States Department of Energy, At COP28, Countries Launch Declaration to Triple Nuclear Energy Capacity by 2050, Recognizing the Key Role of Nuclear Energy in Reaching Net Zero, 01 December 2023

[9] Hansen J, Sato M, Hearty P *et al.* Ice melt, sea level rise and superstorms: evidence from paleoclimate data, climate modeling, and modern observations that 2 C global warming could be dangerous. *Atmos Chem Phys* **16**, 3761-812, 2016

[10] IPCC. *Climate Change 2021: The Physical Science Basis [Masson-Delmotte V, Zhai P, Pirani A et al. (eds)].* Cambridge and New York: Cambridge University Press, 2021

[11] United Nations Framework Convention on Climate Change. *What is the United Nations Framework Convention on Climate Change?* https://unfccc.int/process-and-meetings/what-is-the-united-nations-framework-convention-on-climate-change) (21 July 2024, date last accessed)

[12] Hansen JE, Kharecha P, Sato M *et al.* Global warming has accelerated: are the United Nations and the public well-informed? *Environ.: Sci. Pol. Sustain. Devel.* **67(1)**, 6–44, 2025, https://doi.org/10.1080/00139157.2025.2434494