

The Methane Accelerator

A Whitepaper by the World Business Academy

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With New Scientific Findings from 2020-2025

ABSTRACT

A January 2019 report published in the journal *Science* reveals that ocean temperatures are warming 40% faster on average than was predicted just five years ago by the United Nations' Intergovernmental Panel on Climate Change (IPCC). This is one of many signs that climate change is accelerating, and already producing considerably graver impacts than has been forecasted by all of the leading scientific consensus bodies analyzing the issue. **[2026 UPDATE: Research through 2025 has dramatically confirmed and extended these findings. Ocean heat content reached consecutive record highs in 2023 and 2024, with the warming rate accelerating from 0.14 W/m² during 1960-2025 to 0.32 W/m² during 2005-2025. The 2024 ocean absorbed 16 ± 8 ZJ more heat than 2023.]**

This consistent failure to accurately assess the severity of climate change impacts cannot be explained by traditional models that focus principally on carbon dioxide (CO₂) levels. Future work must account for all contributory factors to fully appreciate the urgency of requisite actions that far surpass those adopted in the Paris Climate Agreement in order to avoid otherwise catastrophic consequences.

The World Business Academy has for over a decade reviewed the same data as other leading climate researchers but has included in its climate change forecasts a factor the IPCC and most leading climate scientists have until recently discounted, or entirely failed to consider. This additional factor concerns the effects of methane (CH₄) being released from thawing permafrost, glaciers and marine hydrates due to atmospheric warming; and the released methane then independently functioning as a powerful accelerant of greater atmospheric heating, faster ice melt, more severe weather disturbances and ocean acidification.

This paper describes a snowball effect, wherein increased atmospheric warming causes the release of methane from vast worldwide deposits, which in turn produces greater warming that results in the release of even more methane. The World Business Academy refers to this Vicious Circle as the "**Methane Accelerator**". The paper (i) describes why this phenomenon exists; (ii) provides scientific references that support this assessment; and (iii) suggests the imminent catastrophic consequences and existential threat of failing to consider the Methane Accelerator in making future forecasts, planning appropriate remedial actions, and estimating the time available in which to agree upon, fund and implement such actions.

In its most disturbing finding, we conclude that when the cumulative effects from the Methane Accelerator are fully considered, mankind is likely to have already passed the "tipping point" where merely reducing CO₂ emissions, even to zero, will not be sufficient to curtail the catastrophic effects of climate change. **[2026 UPDATE: A landmark 2022 study in Science confirmed that current warming of ~1.1°C already lies within the lower end of some tipping point uncertainty ranges, with at least five tipping points potentially triggered**

between 1.5-2°C warming, including Greenland ice sheet collapse, West Antarctic ice sheet collapse, boreal permafrost abrupt thaw, and Labrador Sea convection collapse.]

Geologic records from two prior extinction events that respectively resulted in a mass extinction of deep-sea organisms and in killing over 93% of all life forms on Earth, show compelling evidence linking these events to a rapid escape of methane from marine hydrate reservoirs on continental slopes. As ocean temperatures have risen over the past several decades, we have begun to see a marked increase in methane releases seeping into the water column and atmosphere from hydrate reservoirs.

INTRODUCTION

Current forecasts by the Intergovernmental Panel on Climate Change (IPCC), like the group's prior consensus projections, are unduly optimistic. For example, a January 2019 report published in the journal *Science* reveals that ocean temperatures are warming 40% faster on average than was predicted by the IPCC a mere five years ago. A February 2019 study reveals "very strong methane growth" between 2014 and 2017, and states that the increase in methane "since 2007 was not expected in future greenhouse gas scenarios compliant with the targets of the Paris Agreement."

[2026 UPDATE: The Pattern of Underestimation Has Continued and Intensified]

Research published since 2019 has dramatically confirmed the pattern of systematic underestimation. Slater, Hogg, and Mottram (2020) demonstrated in *Nature Climate Change* that observed ice-sheet losses track the 95th percentile (upper bound) of IPCC AR5 sea-level predictions, with mass loss having quadrupled since the 1990s. Box et al. (2022) found that the Greenland ice sheet's imbalance with recent climate (2000-2019) has already committed at least 274 ± 68 mm of global sea-level rise regardless of 21st-century emissions pathways.

Perhaps most significantly, Rantanen et al. (2022) published definitive evidence in *Communications Earth & Environment* that the commonly cited "twice as fast" Arctic amplification is a significant underestimate. Their analysis found the Arctic warmed nearly **four times faster** than the global average from 1979-2021, with the Eurasian Arctic Ocean warming up to seven times faster. Critically, CMIP5 and CMIP6 climate models underestimate observed Arctic amplification by 29-34%.

Twelve years ago, the World Business Academy (the "Academy") became concerned about the influence of methane releases as a catalyst of accelerating global warming trends. Since 2007, the Academy's consideration of the potentially adverse consequences of methane gas held in frozen reservoirs being released by warmer ocean temperatures has enabled the Academy to correctly predict the consistent understatement of IPCC's consensus estimates with regard both to the magnitude and severity of future climate change effects.

Because CO₂ lingers in the atmosphere for significantly longer than methane, the traditional scientific community has been mesmerized by the truly disturbing rise of CO₂ concentrations, which on May 12, 2019 reached 415 ppm (parts per million) for the first time in human history. **[2026 UPDATE: CO₂ concentrations have continued their relentless rise, exceeding 427 ppm in 2024.]** Until recently, the intense focus on CO₂ has blinded most of the scientific community to the far greater threat to human civilization posed by methane being released from melting permafrost, beneath glaciers and ocean floor sediment, as atmospheric and marine temperatures rise.

Even groups that have expressed concerns about methane traditionally focus on manmade methane emissions rather than natural methane releases triggered by global warming. For example, in 2012, the Environmental Defense Fund (EDF) initiated research to better pinpoint the source of methane leaks. The group explains that curtailing methane emissions is important because "about 25% of manmade global warming we're experiencing is caused by methane emissions [given that during] the first two decades after its release, methane is 84 times more potent than carbon dioxide."

[2026 UPDATE: MethaneSAT Launch and Findings]

The Environmental Defense Fund's MethaneSAT, announced in 2018 and discussed in the original whitepaper, successfully launched on March 4, 2024. During its 15 months of operation before contact was lost in June 2025, MethaneSAT yielded critical findings that confirmed systematic underreporting of methane emissions: • *Permian Basin (US): 280 tonnes/hour emissions with a loss rate of 1.8-2.9%—nine times higher than the 0.2% industry target* • *Turkmenistan: 420 tonnes/hour in South Caspian—more than ten times higher than official database estimates* • *Emissions across multiple basins were found to be 3-5 times greater than EPA gridded inventory estimates*

MethaneSAT's unique capability was quantifying total basin-scale emissions including dispersed smaller sources invisible to other satellites, confirming that official inventories systematically undercount actual emissions. Additional satellite monitoring capabilities have come online, including Carbon Mapper's Tanager-1 (launched August 2024), NASA's EMIT instrument (2022), and Japan's GOSAT-GW (launched June 2025). The IEA Global Methane Tracker now reports 25+ satellites providing methane emissions insights.

The Academy actively supports reducing CO₂ emissions, and agrees with EDF on the importance of reducing methane emissions from oil and gas wells, and pipeline leaks. The Academy also supports policy initiatives such as carbon credits and/or a carbon tax; the development of alternative energy sources; and is optimistic about extracting excessive amounts of CO₂ from the atmosphere using direct carbon capture and sequestration, which are technologically feasible and now appear to be economically viable with projected costs of approximately \$100/ton when built at a utility scale. **[2026 UPDATE: While DAC technology has advanced—Climeworks' Mammoth facility in Iceland (operational May 2024) captures up to 36,000 tonnes CO₂/year—current costs remain closer to \$1,000/ton than \$100/ton, with targets of \$300-350/ton by 2030. Total global DAC capacity in 2024 was approximately 40,000 tonnes CO₂/year—trivial compared to gigatonne-scale removal required.]** Yet this paper addresses a quite different phenomenon for which these sorts of approaches are woefully inadequate.

As noted above, since 2007, the Academy has focused its work regarding climate change on essentially the same data sets used by other leading climate researchers: atmospheric CO₂ increases detected at the Mauna Loa Observatory in Hawaii that are currently higher than at any

time in the last 800,000 years; increasing ambient global moisture levels; shrinking and disappearance of glaciers around the world; increases in ocean temperature; loss of ice mass and the accelerating speed of the seaward advance of the Greenland Ice Sheet and the drastic reduction of certain Antarctic glaciers; dramatic winter and summer ice decreases in the Arctic Circle; growing instability of the jet stream; alteration of ocean currents; increasingly extreme weather events; rising sea levels; and various trends in alternative energy developments and technologies.

The principal difference between the Academy's analyses of these factors and the perspectives on this data by traditional climate researchers, is that for over a decade the Academy has incorporated into its review and consideration of these data classes a concern that (i) the rise in ambient air and ocean temperatures may be triggering the release of methane from natural deposits; and (ii) even if diffused so as not to be locally significant, the derivative increase in methane as this gas is released is in turn accelerating all of the foregoing negative climate change indices.

The Academy refers to this effect as the "Methane Accelerator".

UNDER-ESTIMATING CLIMATE CHANGE TRENDS

In 2012, one thoughtful observer wrote: "Across two decades and thousands of pages of reports, the world's most authoritative voice on climate science has consistently understated the rate and intensity of climate change and the danger those impacts represent." A recent publication describes some of the reasons why:

"The IPCC process suffers from all the dangers of consensus-building in such a wide-ranging and complex arena. For example, IPCC reports, of necessity, do not always contain the latest available information. Consensus-building can lead to 'least drama', lowest-common-denominator outcomes, which overlook critical issues. This is particularly the case with the 'fat-tails' of probability distributions, that is, the high-impact but lower-probability events where scientific knowledge is more limited."

From the Academy's perspective, these challenges associated with the consensus process employed by the IPCC do not fully explain why forecasts made by the world's most astute group of climatologists and experts consistently underestimate future warming, sea rise, ice melt extent and atmospheric methane concentration levels by increasingly wide margins. The IPCC's failure to adequately account for the effects of methane acceleration within its trend analyses adds an earth sciences-based explanation for the differences.

[2026 UPDATE: Comprehensive Evidence of Systematic Underestimation]

Research published since 2019 provides overwhelming evidence that IPCC models systematically underestimate key climate indicators:

Sea Level Rise: Ice-sheet losses track the upper 95th percentile of IPCC projections, not the median. Box et al. (2022) demonstrated that committed sea-level rise from Greenland alone is 274 mm—independent of future emissions scenarios.

Arctic Amplification: The Arctic has warmed nearly four times faster than the global average since 1979 (Rantanen et al., 2022), not twice as commonly stated. CMIP models underestimate this amplification by 29-34%. The NOAA Arctic Report Card 2025 confirms the last 10 years are the 10 warmest on record in the Arctic.

Methane Concentrations: Atmospheric methane reached 1,923 ppb in 2023—the highest in at least 800,000 years—with growth accelerating faster than even the most pessimistic IPCC scenarios. The record growth rate of 15.4 ppb/year during 2020-2022 was the highest since measurements began in 1983.

Ocean Warming: Cheng et al. (2025) reported in *Advances in Atmospheric Sciences* that global upper 2000m ocean heat content reached unprecedented highs in 2024, with the warming rate having accelerated significantly—from 0.14 W/m² during 1960-2025 to 0.32 W/m² during 2005-2025. Ocean heat uptake has nearly doubled during 2010-2020 relative to 1990-2000.

The Academy is convinced that the problem suggested by these observations dictates considerably more aggressive counter-measures, including reversing the warming of the Earth's surface and thereby cooling the ocean temperature to stop further releases from hydrate deposits.

CLIMATE-INDUCED RELEASES OF METHANE FROM NATURAL DEPOSITS

During its research leading up to the 2007 publication of its book, *Freedom from Mideast Oil*, the Academy began to consider the effect methane might have as a heat accelerant and potential that its release could heat the atmosphere beyond what CO₂ emissions alone were doing.

A number of authors have conclusively shown that melting permafrost is releasing methane from thawing ruminant animal remains and other organic materials (e.g., grasses, trees and shrubs) that have been trapped and frozen solid for millennia. A number of other references affirm that increases in ocean temperature are causing massive reserves of ice-like solid structures known as methane hydrates, located on or just beneath the ocean floor, to undergo a phase change into gas, which is then released into the ocean and then the atmosphere.

[2026 UPDATE: Dramatic New Evidence of Permafrost Methane Emissions]

Research since 2019 has revealed that permafrost carbon feedback is more consequential than previously modeled, particularly through mechanisms not captured in climate models:

Abrupt Thaw Doubles Emission Estimates: Turetsky et al. (2020) published in *Nature Geoscience* that abrupt permafrost thaw (thermokarst) across 2.5 million km² could provide climate feedback comparable to gradual thaw from the entire 18 million km² permafrost region. Abrupt thaw increases ¹⁴C-depleted permafrost carbon emissions by 125-190% compared to gradual thaw alone—a process largely missing from climate models.

First Direct Observational Evidence of Increasing Emissions: Rößger et al. (2022) provided the first long-term observational evidence in *Nature Climate Change* that permafrost methane emissions are actually increasing. Using the longest eddy covariance dataset in the Arctic (16 years, Lena River Delta), they documented that early summer emissions increased approximately $1.9 \pm 0.7\%$ per year, linked to air temperature rise of 0.3°C/year in June.

Unexpected Methane Sources: Walter Anthony et al. (2024) discovered in *Nature Communications* that talik development in unsaturated Yedoma uplands produces unexpectedly large methane emissions—nearly three times higher than typical northern wetland emissions annually, with 70% occurring in winter when surface freezing prevents methane oxidation. The 2020 Siberian heat wave triggered methane release from an entirely new source: Froitzheim et al. (2021) documented in *PNAS* methane hotspots from Paleozoic carbonate rock formations, suggesting gas hydrates in geological fractures became unstable due to surface warming.

Based on its review of these studies and related data, the Academy surmises that a snowball effect often referred to as a "Vicious Circle" has been, and is being accelerated as rising ambient air and ocean temperatures trigger the release of methane that has been "locked" in solid hydrate

structures on the ocean floor. For the first few decades following its release, methane emissions are considerably more potent than CO₂.

[2026 UPDATE: Marine Methane Hydrate Dissociation Shows Troubling Signs]

New research confirms ocean warming is destabilizing methane hydrates across multiple regions, with previously unrecognized transport mechanisms:

First Southern Hemisphere Evidence: Ketzer et al. (2020) provided the first evidence from the Southern Hemisphere in *Nature Communications* linking contemporary ocean warming to gas hydrate destabilization. They documented 394 gas flares at the Rio Grande Cone off Brazil, with advective methane flux three orders of magnitude higher than diffusive flux.

Long-Distance Methane Migration Discovered: Davies et al. (2023) overturned assumptions about hydrate vulnerability in *Nature Geoscience*, finding that methane from deep hydrate dissociation can migrate over 40 km and vent through seafloor pockmarks. This means far larger volumes of methane may be liberated from deep hydrate zones than previously assumed.

Extensive Arctic Seepage Documented: Serov et al. (2023) documented over 7,000 methane seeps across the Barents Sea shelf in *Nature Communications*, revealing extensive methane/oil release from geological reservoirs left partially uncapped since deglaciation approximately 15,000 years ago. Steinbach et al. (2021) used triple-isotope analysis to confirm in *PNAS* that elevated methane in the outer Laptev Sea (oversaturation approximately 3,800%) derives from thermogenic and natural gas sources, indicating contributions from both subsea permafrost thaw and deeper hydrocarbon reservoirs.

The Academy is concerned that the status quo—if not abated—will lead to an unceasing acceleration of global atmospheric warming irrespective of additional CO₂ emissions reductions. Thus, by having raised temperatures to the point that vast natural reserves of methane that have been held as hydrates for millennia are now being released at an accelerating pace, it will be these uncontrolled (and uncontrollable) methane releases that accelerate further climate damage.

TWO PRIOR MASS EXTINCTION EVENTS PROVIDE A CONTEXT

There is compelling evidence from geologic records that rapid and massive methane releases from marine hydrates accompanied two previous mass extinction events in the Earth's history.

The most recent of the two events took place approximately 55.8 million years ago during the Latest Paleocene Thermal Maximum (LPTM), also referred to by scientists as the "Initial Eocene" (IE) or the "Paleocene-Eocene Thermal Maximum (PETM)" period. This period, which is marked by the largest mass extinction among deep-sea organisms in the past 93 million years, is widely considered to be the best analog we have for contemporary global warming even though the rate of carbon being released into the atmosphere today is nearly 10 times faster than during the PETM.

The second mass extinction event for which scientists have found compelling evidence of a rapid release of methane from marine hydrate reservoirs is the Permo-Triassic, or end-Permian, which is also colloquially known as the Great Dying or the Great Permian Extinction. This extinction event took place between 252 and 251 million years ago; and is estimated to have killed approximately 90% of marine species, 70% of terrestrial vertebrate species, 30% of insect orders and an indeterminate percentage of terrestrial and marine plants, making it the greatest natural catastrophe ever experienced by life on Earth.

[2026 UPDATE: New Research Strengthens Mass Extinction Parallels]

Research published since 2019 has significantly strengthened the evidence linking methane to mass extinction events:

Wu et al. (2021) published in *Nature Communications* a reconstructed continuous CO₂ record showing atmospheric levels increased from 426 ppmv to 2,507 ppmv within approximately 75,000 years at the Permian-Triassic boundary—requiring large quantities of ¹³C-depleted carbon from organic matter and methane beyond volcanic CO₂ alone.

Chen et al. (2022) provided geochemical evidence in *Nature Communications* that oil-cracked methane emissions from the Emeishan and Siberian Traps Large Igneous Provinces (likely exceeding 10,000 Gt) directly contributed to the end-Permian extinction—the largest in Earth's history with 90% species loss.

This massive release of methane from marine hydrates has been referred to as a "methane burp;" and based on the geologic record, is described as follows: "[Carbon isotopes] show a massive shift towards the light isotope, carbon-12, exactly at the time of the big extinction... The extra carbon-12 was probably buried, frozen deep under the oceans in the form of gas hydrates. These are extraordinary accumulations of carbon-12-rich methane locked up in cages of ice at very high pressure. If the atmosphere and oceans warm up sufficiently, these gas reserves can suddenly melt and release their contents in a catastrophic way."

CLIMATE TIPPING POINTS: 2020-2025 ASSESSMENT

[2026 UPDATE: This section has been added to incorporate major new research on climate tipping points published since 2019.]

Armstrong McKay et al. (2022) conducted the most comprehensive reassessment of climate tipping elements, publishing their findings in *Science*. Their analysis found that current warming of approximately 1.1°C **already lies within the lower end of some tipping point uncertainty ranges**. At least five tipping points could be triggered between 1.5-2°C of warming:

- Greenland ice sheet collapse • West Antarctic ice sheet collapse • Widespread coral reef die-off
- Boreal permafrost abrupt thaw • Labrador Sea convection collapse

Richardson et al. (2023) quantified all nine planetary boundaries in *Science Advances*, finding that six have been transgressed, placing Earth "well outside of the safe operating space for humanity." As Johan Rockström, director of the Potsdam Institute, observed: "We are now in a zone that is unprecedented... pushing the planet to a place that has not existed for millions of years."

The Academy's concern about tipping points relates directly to the Methane Accelerator. The permafrost carbon feedback represents a potential tipping point that, once crossed, could release enormous quantities of methane and CO₂ regardless of human emissions reductions. Natali et al. (2021) warned in *PNAS* that permafrost carbon emissions and Arctic wildfires are not fully accounted for in global carbon budgets informing Paris Agreement commitments, potentially consuming remaining carbon budgets faster than expected.

RECORD ATMOSPHERIC METHANE: 2020-2025

[2026 UPDATE: This section has been added to document the dramatic acceleration of atmospheric methane concentrations since 2019.]

Atmospheric methane concentrations have surged to unprecedented levels, with record growth rates that cannot be fully explained by anthropogenic emissions alone—strongly supporting the Methane Accelerator hypothesis.

The Global Methane Budget 2000-2020, published by Saunio et al. (2025) in *Earth System Science Data*, reveals atmospheric concentrations reached **1,923 ppb in 2023**—the highest in at least 800,000 years—with growth accelerating faster than even the most pessimistic IPCC scenarios. Human activities account for at least two-thirds of emissions, with a 20% increase over two decades, but natural feedbacks are intensifying.

Michel et al. (2024) analyzed the record-high methane growth rate of 15.4 ppb/year during 2020-2022—the highest since measurements began in 1983—publishing their findings in *PNAS*. Isotopic signatures point to **microbial sources** (wetlands, waste, agriculture) rather than fossil fuel emissions or decreased atmospheric oxidation. This finding is consistent with the Methane Accelerator hypothesis: warming is stimulating microbial methane production in wetlands and thawing permafrost.

Zhang et al. (2023) documented in *Nature Climate Change* that the wetland methane feedback has intensified, with 2020-2021 marking "exceptional years" of growth. The positive warming-wetland-methane feedback operates through rising temperatures increasing microbial activity and expanding wetland extent. Critically, **most Earth System Models do not directly incorporate this feedback**—a significant omission that helps explain the systematic underestimation of climate change impacts.

A 2024 analysis published in *Nature Communications* by the Global Carbon Project found that atmospheric methane concentrations—now 2.6 times pre-industrial levels—are rising along the most extreme trajectory used in IPCC emission scenarios. Current process-based wetland models fail to capture tropical emission surges revealed by atmospheric inversions.

OCEAN WARMING ACCELERATION: IMPLICATIONS FOR HYDRATE STABILITY

[2026 UPDATE: This section has been added to document the acceleration of ocean warming and its implications for methane hydrate stability.]

Ocean heat content has reached consecutive record highs, with warming accelerating in the depth zones containing methane hydrates—a development with profound implications for the Methane Accelerator.

Cheng et al. (2025) reported in *Advances in Atmospheric Sciences* that global upper 2000m ocean heat content reached unprecedented highs in 2024, exceeding 2023 by 16 ± 8 ZJ (zettajoules). Multiple ocean regions simultaneously hit records. The warming rate has accelerated significantly—from 0.14 W/m^2 during 1960-2025 to **0.32 W/m^2 during 2005-2025**.

Particularly concerning for hydrate stability, Li et al. (2023) found in *Nature Communications* that ocean heat uptake has nearly doubled during 2010-2020 relative to 1990-2000, with 89% occurring in mode and intermediate water layers—the same depth range (300-1500m) containing shallow methane hydrates.

Johnson and Purkey (2024) provided the first comprehensive analysis in *Geophysical Research Letters* showing deep ocean warming, with globally integrated heat content trends of 21.6 ± 6.5 TW in the 2000-4000m layer and 12.9 ± 1.8 TW in abyssal waters. This warming at depth threatens methane hydrates that were previously considered stable.

Zeng et al. (2025) documented in *Science* that 2023 marine heatwave activity totaled 53.6 billion $^{\circ}\text{C}\text{-days}\text{-km}^2$ —more than three standard deviations above normal—with 96% of ocean surfaces experiencing heatwave conditions at some point during the year.

THE NEED FOR URGENT ACTION

The Academy has discussed this topic with other scientific groups, many of which have been reticent to openly discuss the implications of methane acceleration because it could create widespread panic if fully understood. Yet they privately agree that merely curtailing CO₂ emissions at this point is "too little, too late;" and to reverse the trends requires:

- (1) CO₂ removal on a global scale, using both natural reforestation, ecosystem restoration, and direct air capture and sequestration technologies; and
- (2) reducing ocean temperatures worldwide so that marine hydrates will stay in solid form rather than continuing to release methane in increasing quantities.

[2026 UPDATE: Status of Carbon Removal Technologies]

Direct Air Capture (DAC) technology has advanced since 2019, but remains orders of magnitude below required scale. Climeworks' Mammoth facility in Iceland (operational May 2024) captures up to 36,000 tonnes CO₂/year—ten times larger than its predecessor Orca—with 10-20% capex reduction per tonne. However, current costs remain "closer to \$1,000/ton than \$100/ton" according to Climeworks' CEO, with targets of \$300-350/ton by 2030.

Sievert et al. (2024) projected DAC costs at 1 Gt cumulative capacity in *Joule*: \$341/tCO₂ for liquid solvent systems, \$374/tCO₂ for solid sorbent, and \$371/tCO₂ for calcium oxide weathering—significantly above industry targets. Young et al. (2023) concluded in *One Earth* that costs are unlikely to reach the US target of \$100/tCO₂ except under very ambitious assumptions.

Total global DAC capacity in 2024: approximately **40,000 tonnes CO₂/year**—trivial compared to the gigatonne-scale removal required to meaningfully address climate change. This stark gap between current capability and required scale underscores the urgency of the Academy's call for action.

Because CO₂ is ambient at low altitudes in air and in seawater, its removal anywhere lowers CO₂ concentrations everywhere. The problem is the scale required to create a meaningful positive climate impact. The Academy believes that a carbon tax represents the best capital markets mechanism to make those parties who emit carbon bear the responsibility for its adverse effect, as well as a catalyst for adoption of alternative technologies with a reduced carbon footprint.

The Academy supports the imposition of a carbon tax of at least \$100/ton in order to incentivize capital investment in DAC technology. At this price, fossil fuel companies who emit CO₂ would pay at least as much as it costs society to recapture the CO₂ gas (and preferably a bit more to account for transaction costs) and either sequester or utilize it in a carbon-neutral or carbon-free manner.

With respect to methane, the Academy believes we must reduce the amount of radiant energy in order to cool the Earth's surface and lower ocean temperatures, and thereby to slow the rate of ice melt and methane releases from permafrost and marine hydrates. We have reviewed a number of proposals that have been made for albedo modification through direct climate interventions and/or geoengineering strategies such as stratospheric aerosols and marine cloud brightening as a means to cool the Earth's surface. The Academy believes such proposals present unacceptably high risks and introduce the potential for numerous unforeseen and unmanageable adverse consequences.

CONCLUSION

In confronting climate change, we face a much different adversary, and a much more powerful one. At this time, only global solutions that can push the climate back into a state that we know is sustainable are of any utility. Nothing else will enable humanity to avoid hitting the brick wall towards which we are racing.

It is no longer a question of whether geoengineering should be considered, but rather a consideration of which strategies for cooling the planet are technologically feasible, present the fewest adverse consequences, have the best chance of success, and assure the least risk of unintended consequences.

[2026 UPDATE: Summary of Evidence Since 2019]

Research from 2020-2025 substantially validates and extends the World Business Academy's Methane Accelerator thesis. The key findings include:

Systematic IPCC underestimation confirmed: Ice sheet losses track worst-case scenarios, Arctic warming is nearly 4× (not 2×) global rates, and methane concentrations follow the most extreme projections. Climate models underestimate Arctic amplification by approximately 30%.

Methane feedbacks intensifying: Both permafrost and wetland methane feedbacks show observational evidence of acceleration, with abrupt thaw potentially doubling emission estimates. These feedbacks remain poorly represented in climate models.

Tipping point risks elevated: Current warming already places several tipping points within uncertainty ranges, with five potentially triggered between 1.5-2°C. Six of nine planetary boundaries have been transgressed.

Satellite monitoring reveals systematic inventory underestimation: MethaneSAT and complementary satellites consistently find emissions 3-10× higher than official estimates, particularly from fossil fuel infrastructure.

Technological solutions lag far behind: DAC capacity remains at trivial scales with costs 3-10× above targets, while the carbon removal requirement grows annually.

These findings underscore that the "vicious circle" feedback loop described in the original 2019 whitepaper is operating—and potentially accelerating—with climate system responses consistently exceeding model projections.

As Franklin Roosevelt said on D-Day exactly 75 years before the original publication of this paper: we must "set upon a mighty endeavor, a struggle to preserve our Republic, our religion and our civilization, and to set free a suffering humanity."

It is the Academy's sincere hope that this analysis, now updated with nearly seven years of additional scientific evidence, will help attract serious consideration, and in turn help preserve human civilization as we know it.

Rinaldo S. Brutoco, Chief Executive Officer World Business Academy

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