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THE EARTH'S ENERGY IMBALANCE AND THE REFLECTIVITY CRISIS

THE SECOND GLOBAL WARMING PROBLEM



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EXECUTIVE SUMMARY

In recent years, a second dimension to the global warming problem has emerged. This is not yet widely appreciated in the climate policymaking community but is becoming increasingly urgent and cannot be immediately addressed using the conventional tools of climate mitigation. This is the Earth's 'reflectivity crisis.' In essence, our planet has got darker, and is therefore absorbing more solar radiation and heating up more quickly.

This darkening has been the largest single contributor to the recent much-discussed rapid acceleration in global temperature. Much of it is feedback to greenhouse warming rather than an independent driver, so while cutting emissions to zero remains the only long-term route to restoring planetary energy balance, it is not one that operates quickly enough to prevent a damaging climate overshoot. The Earth's reflectivity crisis therefore demands a paradigm shift in our approach to climate, particularly for the most vulnerable countries and communities.

The magnitude of the reflectivity crisis is stark. The Earth's energy imbalance (EEI) has more than doubled in two decades, from 0.5 W/m² (watts per meter squared) in the 2000s to about 1.0 over 2013-2022. Satellite estimates put the

trend at 0.44 per decade over 2001 to 2025, and independent ocean measurements put it at roughly 0.30. Around 91 percent of the additional heat has gone into the oceans, and the remainder is driving surface air temperature towards permanently exceeding the Paris limits.

With a super-El Niño now gathering force in the tropical Pacific, it is expected that 2027 will set a new record for observed planetary temperature of about 1.7°C above pre-industrial, perhaps with brief periods even above 2°C. It is now expected that the 20-year average 1.5°C limit will be definitively crossed before 2030 and the 2°C line by around 2048. Even while the clean energy transition is accelerating around the world, it is no longer realistic to expect GHG mitigation approaches to save the Paris target.

So why is EEI increasing so fast? This is not a natural phenomenon. Partly it is an unhappy accident, because efforts to clean up aerosol pollution have removed inadvertent cooling that was never accounted for in previous warming projections. This comes from desulfurization in East Asia, with the 2020 International Maritime Organization (IMO) shipping sulphur regulations adding to the problem. This cooling is both because sulfate particles themselves have a reflective effect, and because they act as nuclei, making clouds brighter and longer lasting. White low-level clouds are highly reflective, and their decline is the biggest contributor to the higher EEI, although only part of that decline is attributable to cleaner air.



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Clouds are also affected by warming directly, this is the most rapid and most important feedback on climate change. Higher temperatures change cloud dynamics and appear to be reducing the extent of low-level highly reflective clouds. Studies of the satellite record attribute about 62 percent of the increase in absorbed sunlight to cloud change and about 27 percent to reduced snow cover and sea ice. Thus, the reduction in snow cover and sea ice, particularly in the Northern Hemisphere and also driven directly by global heating, is also helping drive the increase in EEI.

The Paris temperatures were identified by world leaders as the level beyond which global warming should not pass. They also anchor key several Earth system tipping points, which can be directly damaging with irreversible effects, and can further drive global heating. The most exposed cluster between 1.5°C to 2.0°C includes tropical coral reefs, the Greenland and West Antarctic ice sheets and mountain glaciers. Widespread coral die-off has already been assessed as the first tipping point definitively crossed. Amazon dieback and Atlantic overturning collapse sits further out, centrally at 3.5°C and 4.0°C, although the lower bounds of both reach into the range now being entered, at 1.4°C.

The fact that the changing EEI of the planet is human-driven and is partly down to the removal of sulphate aerosols from the lower atmosphere has led to a renewed interest in 'sunlight reflection methods' (SRM). One of these would involve deliberately adding sulphates to the stratosphere to restore the lost tropospheric cooling, analogous to the cooling impact of Mount Pinatubo, the 1991 volcanic eruption that reduced global mean temperatures by about

0.5°C for two years.

SRM is a way to address EEI directly, and looks now like the only realistically achievable way to deliver on the Paris targets. However, it is controversial and opposed by many in the climate community who fear the moral hazard of a 'quick fix' that could reduce the pressure for sustained carbon emissions cuts. Others object on the grounds of governance, equity, termination shock and concerns about unknown risks. The moral hazard concern is reasonable, and nobody disputes that global net zero is the only long-term way to stabilize planetary temperatures by bringing the Earth back into energy balance. However, SRM could avoid a short-term (decades-long) highly damaging overshoot and the crossing of irreversible Earth system tipping points for which there are no other strategic options.

Climate-vulnerable countries have so far had little collective voice in this debate, although individual members have taken clear positions, with a number of African states and Pacific small islands developing states supporting a Non-Use Agreement on Geoengineering. EEI has also not yet penetrated into the COP process, although in March 2026 the World Meteorological Organization elevated it to a headline climate indicator for the first time.

The CVF-V20 Office of the Chief Scientist now has work programmes on these issues, is available to brief ministers and will produce more briefings giving fuller attention as the situation changes. Whatever their respective positions, CVF countries must be leaders, not laggards, in the debate about what level and type of risk is tolerable for their nations and populations.

1. INTRO- DUCTION

Global warming is happening because the Earth is absorbing substantially more energy than it radiates back to space, and the rate of heat accumulation has risen sharply since the 1970s. Over 2006 to 2025, the imbalance averaged 1.04 watts per square meter, with a range of 0.82 to 1.25. Over 1976 to 1995, it averaged 0.40 watts per square meter, with a range of minus 0.03 to 0.84¹. The earlier figure is imprecise enough to include zero, so the comparison should be read as a clear and large increase rather than an exact multiple. However, it is correct to say that the Earth's energy imbalance has roughly doubled over the last two decades. In March 2026, the World Meteorological Organization elevated Earth's Energy Imbalance (EEI) to a headline climate indicator for the first time².

Three things follow, and together they amount to a substantial change in how the climate problem should now be understood.

- **The optimistic end of the range is closing.** Observation is eliminating the low end of climate sensitivity, which is the end on which every argument for a slower and cheaper transition has depended. Section 3 sets this out.
- **Declining reflectivity is a major driver of increased EEI.** The planet is absorbing more solar radiation because it has become less reflective. Cloud change dominates, ice and snow loss contributes, and the deliberate removal of cooling sulfate pollution has unmasked latent warming that was previously hidden by tropospheric sulfate emissions. Sections 4 and 5 set this out.

- **Overshoot is now the mainstream planning assumption.** On present trajectories, the 1.5°C limit is passed on a 20-year averaged basis around 2030 and 2°C around 2048³. Several crucial Earth system tipping points sit at or below those levels. Section 9 sets out what missing the Paris goals means for planetary governance.

For the 74 member states of the CVF-V20, representing 1.81 billion people⁴, the practical consequence is twofold. A large share of the warming, sea level rise and ocean heat that will shape the coming decades is already committed by energy the planet has absorbed. And the possibility that the world might turn out to be lucky on sensitivity, which has quietly underwritten a decade of delay, is being eliminated by measurement.

2. SURFACE TEMPERA- TURE IN THE NEAR-TERM

With El Niño conditions developing in the tropical Pacific, the next two years are likely to set records.

- **What the agencies say.** The WMO predicts annual global mean temperature in the range 1.3 to 1.9°C above pre-industrial for each year from 2026 to 2030, and puts the likelihood that at least one of those years temporarily exceeds 1.5°C at 91 percent⁵. Global mean temperature in 2025 was $1.44 \pm 0.13^\circ\text{C}$, ranking second or third depending on the dataset⁶.

- **What the individual forecasters say.** Former NASA climate scientist James Hansen projects a record of 1.7°C in 2027⁷. An independent forecast from Zeke Hausfather gives a central estimate of 1.57°C with a range of 1.30 to 1.76⁸. In all likelihood, we are looking at 1.7C next year, with a potential short-term hit even as high as 2°C above pre-industrial, which would be a huge world news event.
- **On the rate of warming, there is a real and unresolved dispute.** The assessed value for human-induced warming is 0.25°C per decade over 2016-2025, with a range of 0.2 to 0.4¹. Variability-adjusted analyses put the recent rate at the top of that range rather than beyond it. Whether this constitutes acceleration is contested, with Forster calling the term difficult to establish mathematically, Mann seeing no evidence for it, and Hausfather noting that removing El Niño influence is more art than science⁹. The disagreement is about method, not about data. On that basis, we suggest CVF members can say in line with the science that **the rate of global warming has roughly doubled over the last 20 years**⁹.
- **On when the Paris limits are passed.** A widely cited analysis puts 1.5°C at around 2030 on a central estimate, and 2°C at around 2048 with a range of 2040 to 2062³. Note that this uses a thirty-year smoothing method rather than the Intergovernmental

Panel on Climate Change (IPCC) definition based on a twenty-year average, and that under the IPCC definition the world will not know for certain that 1.5°C has been passed until roughly a decade after the event.

3. LOW-SENSITIVITY MODELS ARE BEING RULED OUT

- **The low end of climate sensitivity is being ruled out because climate models with low sensitivities cannot reproduce the current increased EEI.** This is the single most consequential development, and it has not been widely understood. Analysis of the observed imbalance finds that every climate model with an equilibrium sensitivity at or below 2.93°C falls outside the range the satellites measure, at the 99.999 percent level of the distribution¹⁰.
- **The models that cannot reproduce current EEI trends are the same models that set carbon budgets.** The same modeling framework that fails to reproduce the



Photo credit: January 2019, Ethiopian women carry heavy cans of water in the remote Seharti District, Tigray, Ethiopia | Tewodros Hailemichael | Shutterstock

observed imbalance is the framework used to calculate remaining carbon budgets, to run impact assessments and to underpin national planning. Published work finds that coupled models systematically underestimate the radiation response to surface warming¹¹. A 2025 paper in Nature argues that alongside the familiar climate crisis there is a second one inside climate science, in which accumulating anomalies can no longer be absorbed by the standard approach¹². This is a limitation acknowledged from inside the field, which changes future warming trajectory assumptions fundamentally.

- **A word of caution.** None of this shows that warming is running faster than the central estimate of models. It shows that the range of plausible outcomes has narrowed and that the reassuring low-warming tail has been cut off. Models reproduce the size of the imbalance reasonably well, and after correcting for energy leakage and drift, thirteen of thirty reproduce the observed magnitude, with every observed annual value falling within the model range¹³. What they do not reproduce is the trend and specifically its shortwave component, which is where low-sensitivity models fail and why they are ruled out¹³. A preprint from the Zurich group, not yet peer-reviewed and noted here only as a direction of travel, raises the transient response range to 1.9 to 2.6 Kelvin against an IPCC best estimate of 1.8¹⁴.

4. THE EARTH'S REFLECTIVITY CRISIS - THE OTHER GLOBAL WARMING PROBLEM

- **The Earth's energy imbalance trend is real, large and growing, and supported by two independent lines of evidence.** Two independent measurement systems detect and evidence EEI change. Satellite radiation measurements from the CERES instruments give a trend of 0.44 ± 0.13 watts per square meter per decade over 2001 to 2025. Ocean heat measurements from the Argo float array give 0.30 ± 0.1 over the same period¹. The two agree on direction and on the fact of acceleration. They do not yet agree on magnitude, and reconciling them is an acknowledged priority. Roughly 91 percent of the excess energy has gone into the ocean since the 1970s¹. In 2025 the upper 2,000 meters of ocean gained 23 ± 8 zettajoules

more heat than in 2024, a further record¹⁵. An independent assessment puts the imbalance at 1.0 ± 0.2 watts per square meter over 2013 to 2022, against 0.5 ± 0.2 over 2000 to 2010¹⁶, also suggesting a doubling of EEI.

- **The planet has become darker, and clouds dominate the change.** Earth reflects roughly 29 percent of incoming sunlight, but that fraction has fallen by about 0.5 percent since 2000¹⁶. Satellite measurements put the increase in absorbed solar radiation at about 0.71 watts per square meter per decade. Clouds are the most reflective feature of the planet as seen from space, and the bright low marine stratocumulus decks that sit over the cooler eastern margins of the tropical oceans do more of that work than any other cloud type. Satellite data attributes about 62 percent of the increase in absorbed sunlight to changes in cloud, and about 27 percent to darkening land and ocean surfaces as snow and sea ice retreat¹⁷. This record-low planetary albedo has been shown to account for the otherwise unexplained portion of the 2023 temperature anomaly¹⁸.
- **Models understate the pace of change with the study that has tested this most directly found a 10 to 40 percent underestimation in albedo change over 2001 to 2019, using atmosphere-only models forced with observed sea surface temperatures¹⁹.** A workshop of 44 researchers convened at Ringberg Castle in March 2026 put the increase at 0.3 to 0.5 watts per square meter per decade over 2005 to 2024 and confirmed that shortwave changes (i.e. incoming solar radiation no longer being reflected) dominate the trend²⁰.
- **The remaining carbon budget is close to**

spent. The remaining carbon budget for a 50 percent chance of holding 1.5°C stands at 130 gigatonnes of carbon dioxide from the start of 2026, a little over three years at current emissions¹. The fact that individual years have already exceeded 1.5°C does not contradict this estimate because the two measures use different definitions. The carbon budget is tied to the long-term level of human-induced warming, assessed over a 20-year period, which reached 1.37°C in 2025. Individual years can temporarily rise above this underlying level because natural variability, including El Niño, can add to human-induced warming¹. There is therefore still a small remaining carbon budget under this definition, but it is rapidly being depleted and represents only a 50 percent chance of limiting long-term warming to 1.5°C, not a guarantee.

5. THE SULFATES PROBLEM

One component of the reflectivity decline is different in kind from the others, and it deserves separate treatment because it is a policy result rather than a physical feedback from warming. This is the recent decline in sulfur emissions due to air pollution controls, which has given a substantial boost to global warming in a way that was not considered before implementation.

- **Why does sulfur cool the planet?** Sulfate particles reflect sunlight directly from their shiny surfaces. The larger effect, however, is indirect in that sulfate acts as a condensation

nucleus on which water vapor forms droplets, so it creates low clouds in clear air, makes existing clouds denser and brighter, and lengthens cloud lifetime. This is why ship tracks were historically visible as bright white lines drawn across otherwise cloud-free ocean. Those tracks have now largely disappeared due to the implementation of IMO sulfur emissions controls in shipping. The direct effect is easier to measure, but the indirect effect is larger, which is the exact impact is still highly uncertain.

- **Sulfate cooling is not in doubt.** The eruption of Mount Pinatubo in 1991 injected roughly 17 megatonnes of sulfur dioxide into the stratosphere and cooled the planet by about 0.4°C in the following two years, with Northern Hemisphere surface cooling reaching 0.5 to 0.6°C²¹. For the human-made equivalent, the IPCC assessed total aerosol effective radiative forcing at minus 1.06 watts per square meter for 1750 to 2019, and the current update gives minus 0.96 for 1750 to 2025, having weakened by about 0.1 over 2020 to 2025 as sulfur emissions fell¹. In plain terms, roughly half a degree of warming is thought to still be hidden by aerosol pollution²². However, the net effect of all non-greenhouse human forcings together is only minus 0.28°C for 2016 to 2025, because warming agents such as black carbon and ozone - also components of tropospheric pollution - partly cancel the

sulfate cooling¹.

- **The accounting failure.** This is the part that has not been properly absorbed by policymakers. The assumption underlying net zero pathways was always that as the world stopped burning fossil fuels, the loss of sulfate cooling would be offset by the simultaneous reduction in carbon dioxide forcing. The two would decline together. What is happening instead is that the world is continuing to burn fossil fuels while stripping the sulfates out separately, through the International Maritime Organization regulations completed in 2020 and through desulfurization at Asian coal-fired power stations. The cooling is thus being removed without the warming being removed with it. This has been described as an inadvertent negative geoengineering experiment, producing a small termination shock of rapid planetary warming²³. It was not considered by the IMO negotiators when the sulfur rules were agreed.
- **How large, and for how long.** Estimates of the shipping regulation alone range from 0.07 to 0.2 watts per square meter and are not strictly comparable, because the high end is an average over the global ocean rather than a global mean also including land^{23,24,25}. Cleaner air over East Asia is estimated to contribute $0.05 \pm 0.04^\circ\text{C}$ per decade to the post-2010 warming rate,



Photo credit: June 1991, Mount Pinatubo eruption seen from inside the US military Clark Air Base in Angeles, Pampanga, Philippines | Arjan Naeg | Getty Images

which the authors describe as an upper limit²⁶. However, this is a one-off unmasking rather than a permanent new condition or an escalating feedback. Once the aerosol load has fallen, it cannot fall again. The masked warming is revealed once, and then the effect is spent unless sulfur emissions rise again.

6. CAUSES OF THE EARTH'S REFLECTIVITY CRISIS

The exact contributions of the different elements to the Earth's reflectivity decline are not settled. Three explanations compete.

○ **Aerosol reduction, the forcing explanation.**

One group ascribes roughly half the increase in the imbalance trend over 2001 to 2019 to aerosol reductions, and puts the aerosol share of the total forcing trend at about 38 percent¹⁹. Global sulfur dioxide emissions fell from 81.4 to 69.6 million tonnes between 2019 and 2020, although that single-year fall reflects pandemic shutdowns as well as the shipping rule and Asian desulfurization, and has since partly reversed²⁷. Against this, one study using two independent aerosol indicators over nearly the same period finds hemispheric changes largely cancel and contribute negligibly²⁸.

○ **Cloud change, the feedback explanation.**

The decline in low cloud contributes $0.22 \pm$

0.07 watts per square meter per decade of extra absorbed sunlight over 2003 to 2024, roughly half the growth in the EEI. Cloud feedback accounts for 0.09 ± 0.02 of that, greenhouse gas adjustment for 0.05 ± 0.03 and aerosol adjustment for 0.03 ± 0.03 , together 74 percent of the trend²⁹. A separate analysis attributes about 82 percent of the shortwave trend to the contraction of the world's storm cloud zones as atmospheric circulation shifts poleward³⁰.

○ **Ocean warming patterns, the third explanation.**

Where the ocean warms matters as much as how much. Convection over the western Pacific warm pool lifts heat to where it escapes to space efficiently, which acts as a radiator and lowers effective sensitivity. If models get the pattern wrong, they get the imbalance wrong.^{20,31}

Two cautions on the arithmetic. If aerosols explain about half and clouds explain about half, the two appear to close the account. They do not. Some cloud effects caused by fewer aerosols are counted in both analyses, so the halves overlap³¹. And the quantity models find hardest to reproduce is not the size of the imbalance but the degree to which falling reflectivity dominates it.

The outlying position, stated accurately. James Hansen and co-authors argue that the darkening of the planet since 2000 has increased absorbed solar energy by 1.7 watts per square meter, and that if it were a climate forcing this would be equivalent to a carbon dioxide increase of 138 parts per million³². They are clear that this is a cloud feedback resulting from global warming rather than a forcing due to sulfates, however, so it is not accurate to use this figure to suggest global warming has somehow doubled.



7. WHAT THIS DOES NOT MEAN

There are misreadings circulating and members should be equipped to rebut them. To be clear;

- **It does not mean warming is solely caused by albedo rather than carbon dioxide.** The cloud and cryosphere components of the reflectivity decline are a response to greenhouse warming rather than an alternative to it. The largest single component of the low cloud decline is a feedback, which by definition is driven by the warming itself¹³. The aerosol component is different in kind, being a change in forcing caused by cleaner air rather than a feedback to warming, and is treated separately. This is because the albedo change is either a consequence of greenhouse warming or a consequence of a separate human decision to cut pollution. No author cited in this brief supports the inversion of that causality.
- **It does not mean that long-term energy balance can no longer be restored by**

cutting emissions to zero. This claim circulates, and it is not supported. Feedbacks scale with temperature, so they stop growing when warming stops and reverse when it reverses. The assessed zero-emissions commitment is close to zero, meaning temperature stabilizes and the imbalance decays towards zero once emissions cease, albeit at a permanently higher temperature³³. Aerosol unmasking is the one component that behaves differently, and it is a one-off of roughly half a degree rather than a permanent barrier.

- **It does not mean climate models are worthless.** Models capture the physics of greenhouse warming and reproduce the magnitude of the imbalance reasonably well¹³. What they fail to reproduce is the trend, and specifically the dominance of the shortwave component. That is a serious and acknowledged limitation, and it is narrower than the headlines imply.
- **It does not directly shrink the remaining carbon budget.** The budget is computed from cumulative emissions and transient response, not from the energy imbalance. The link runs through the elimination of low sensitivity, which tightens long-term budgets, and through faster near-term warming.

8. THE UPSHOT FOR CLIMATE VULNERABLE STATES

- **EI is already driving the climate extremes CVF members are experiencing.** Accumulated top-of-atmosphere heating over November 2022 to November 2023 was more than 75 percent larger than during the onset of the comparable El Niño events of 2009 and 2015, and the resulting increase in heat content in the upper 100 meters of ocean was more than 50 percent larger³⁴. The authors link this influx directly to the exceptional extremes of 2023 and 2024, which exceeded what the surface temperature trend alone would predict. Their framing is that these events sit beyond the new normal. A follow-up study attributes about 75 percent of that extreme uptake to the transition from a multi-year La Niña to El Niño³⁵. That second figure is a different quantity from the first and the two are easily confused in press coverage. For member states this is the mechanism by which an abstract radiation measurement becomes a particularly damaging flood, drought or cyclone season.
- **Committed heat, not current temperature, sets the adaptation task.** Roughly 91 percent of the imbalance enters the ocean, where it is released back over decades to centuries. Thermal expansion accounted for 43 percent of sea level rise over 1960 to 2023 and 41 percent of its acceleration³⁶. Sea level rose at 3.84 millimeters per year over 2018 to 2025, roughly double the 1901 to 2025 average of 1.85 millimeters per year¹. Sea level rise commitments are multi-meter over a timescale of many centuries³⁷.
- **Surface temperature understates the emergency.** Annual temperature figures are heavily modulated by El Niño and La Niña. Global mean temperature in 2025 was $1.44 \pm 0.13^{\circ}\text{C}$ above pre-industrial, ranking second or third depending on the dataset and falling below the 2024 record²⁶. The energy imbalance did not fall. Governing by surface temperature invites the argument that the crisis has paused. It has not.
- **Tipping points sit closer than the headline framing suggests.** The most recent assessment concludes that widespread warm-water coral die-off is the first climate tipping point to have been crossed, and that current warming of 1.3 to 1.4°C already exceeds the estimated threshold for warm-water reefs³⁸. Members should be precise about the others, because a common framing places them all at or just beyond 2°C and that is wrong in both directions.



TIPPING ELEMENT	CENTRAL THRESHOLD ESTIMATE
Warm-water coral reefs	1.5°C. Assessed as already crossed.
Greenland Ice Sheet	1.5°C, range 0.8 to 3.0
West Antarctic Ice Sheet	1.5°C, range 1.0 to 3.0
Labrador and subpolar gyre convection	1.8°C, range 1.1 to 3.8
Mountain glaciers	2.0°C, range 1.5 to 3.0
Amazon dieback	3.5°C, range 2.0 to 6.0
Atlantic overturning circulation	4.0°C, range 1.4 to 8.0

Central estimates from the standard assessment³⁹, with the current position updated by the 2025 report, which lowers the Amazon lower bound to 1.5°C and places permafrost, Greenland, West Antarctica and the subpolar gyre just above 1.5°C³⁸. Three of the seven sit at or below 1.5°C. Two sit well beyond 2°C on their central estimates but have lower bounds that reach into the range the world is now entering.

○ **The satellite measurement system that detects EEI is at risk.** Six CERES instruments fly on four aging satellites, of which five are operating after the FM2 instrument on Terra was switched off in January 2025⁴⁰. NASA projects the end of Terra science activities around February 2027⁴⁵. The successor instrument, Libera, completed environmental testing in January 2026 but does not launch until 2027, on JPSS-4⁴². A record whose value rests on continuity therefore faces a gap. NASA's

lead CERES scientist states plainly that there are currently no plans for Earth radiation budget measurements after Libera⁴⁰. The United States budget request for financial year 2027 proposes cutting NASA Earth Science from 2,153 million to 1,021 million United States dollars, and remains unresolved⁴².

○ **The assessment window is narrow and open now.** The IPCC Seventh Assessment Report (AR7) Working Group I First Order Draft is open for expert review from 10 August to 2 October 2026⁴³. The AR7 timeline was closed without a decision at the sixty-fourth plenary session and carries over⁴⁴, a repeated failure described as unprecedented in IPCC history⁴⁵. The findings in Section 3 are recent enough that whether they are properly assessed in AR7 depends on decisions being taken in the next ten weeks.

9. CLIMATE OVERSHOOT OR ALBEDO GOVERN- ANCE?

- **Overshoot is now the realistic planning assumption.** The remaining budget for 1.5°C is a little over three years of current emissions¹, and the smoothed trajectory passes that level around 2030³. Planning on the basis that overshoot will be avoided is no longer prudent for climate vulnerable states, whatever position members take in negotiations. The relevant question becomes how deep the overshoot is, how long it lasts, and what is crossed while it is underway.
- **The governance gap.** Discussion of the planet's reflectivity has not entered the COP process in any form. There is no negotiating track, no reporting requirement, and no agreed terminology, despite reflectivity now being the dominant contributor to the growth in the energy imbalance. That gap exists whether or not any state ever contemplates intervening deliberately, because the reflectivity change is already happening as an unintended consequence of air quality policy. The absence of governance is not a neutral position. It means the largest recent change in the planet's energy budget is unowned and ungoverned.
- **Why solar radiation modification is being discussed, and on what grounds.** Overshoot is now likely. Several tipping elements sit within or below the overshoot range.

Mitigation, however rapid, cannot retire those risks on the timescale over which they would be run, because the carbon already emitted commits warming that persists. Solar radiation modification is one of the few proposals that operates on that timescale and could quickly cool the planet sufficiently to avoid overshoot. Whether it should be used, by whom, under what governance and with what liability are open questions, and they are being answered at present without the participation of the states most exposed to the outcome.

- **There is an added reason this sits with vulnerable states specifically.** The reflectivity decline is in substantial part the result of removing sulfate pollution, an inadvertent negative geoengineering that no one decided upon and no one governs. Some have proposed replacing that cooling sulfur deliberately, in the stratosphere rather than the troposphere, where particles persist longer and have fewer direct health effects. The point for members is not whether that is wise. It is that a decision of this magnitude has already been taken by default once, through the IMO, without those most affected being consulted about the resultant warming impacts.
- **The CVF-V20 position.** The Forum is building a climate emergency and climate intervention workstream. Its purpose is capacity, not advocacy. The aim is to equip member states to participate in informed decision-making and to take informed sovereign positions, including positions of opposition. That framing is deliberate, because members do not hold a single view. Some African states and Pacific small island developing states have supported a Non-Use Agreement⁴⁶, and that position is as much a sovereign choice requiring technical grounding as any other. A full



discussion of the merits and risks of solar radiation modification sits outside the scope of this note and will follow separately.

10. RECOMMENDATIONS

1. Adopt EEI as a standing indicator in CVF reporting alongside temperature and emissions, following the WMO's March 2026 lead rather than waiting for the UNFCCC to catch up.
2. Table the continuity of Earth radiation

budget observation as a CVF position ahead of COP31 in Antalya, 9 to 20 November 2026. The states least responsible for the imbalance are the most exposed to losing the ability to measure it.

3. Raise the absence of any albedo or reflectivity item in the United Nations Framework Convention on Climate Change (UNFCCC) process as a governance gap in its own right, distinct from any position on deliberate intervention.
4. Engage with the CVF workstream on climate emergency and interventions, so that the broadest perspectives among the membership can be fully reflected and represented.

ENDNOTES

- ¹ Forster, P. M. et al. (2026). [Indicators of Global Climate Change 2025: annual update of key indicators of the state of the climate system and human influence.](#) Earth System Science Data, 18, 3889–3933.
- ² World Meteorological Organization (2026). [State of the Global Climate 2025.](#) WMO-No. 1391. Published 23 March 2026.
- ³ Hausfather, Z. (2024). [Analysis, what record global heat means for breaching the 1.5C warming limit.](#) Carbon Brief, 13 June 2024.
- ⁴ CVF-V20 (2026). [Call for Nominations, Secretary-General of the Climate Vulnerable Forum and the Vulnerable Twenty Group.](#) Posted 5 February 2026.
- ⁵ World Meteorological Organization (2026). [Global Annual to Decadal Climate Update 2026–2035.](#) Published 28 May 2026.
- ⁶ World Meteorological Organization (2026). [WMO confirms 2025 was one of the warmest years on record.](#) Published 14 January 2026.
- ⁷ Hansen, J. et al. (2025). [Global Temperature in 2025, 2026, 2027.](#) Columbia University, 18 December 2025. Not peer-reviewed.
- ⁸ Hausfather, Z. (2026). [My 2026 and 2027 global temperature forecasts.](#) The Climate Brink.
- ⁹ Carbon Brief (2026). [Factcheck, why the recent acceleration in global warming is what scientists expect.](#)
- ¹⁰ Myhre, G., Hodnebrog, Ø., Loeb, N. G. & Forster, P. M. (2025). [Observed trend in Earth energy imbalance may provide a constraint for low climate sensitivity models.](#) Science, 388(6752), 1210–1213. Published 12 June 2025.
- ¹¹ Olonscheck, D. & Rugenstein, M. (2024). [Coupled Climate Models Systematically Underestimate Radiation Response to Surface Warming.](#) Geophysical Research Letters, 51(6), e2023GL106909. Published 13 March 2024.
- ¹² Shaw, T. A. & Stevens, B. (2025). [The other climate crisis.](#) Nature, 639, 877–887. Published 26 March 2025.
- ¹³ Bimpiri, N., Hocking, T. & Mauritsen, T. (2026). [Climate models with moderate climate sensitivity best simulate the magnitude of Earth's energy imbalance.](#) Earth System Dynamics, 17, 877–892.
- ¹⁴ Gyuleva, G., Fischer, E. M., Knutti, R. & Sippel, S. (2026). [Recent Temperature and Energy Imbalance Trends Point to Higher Estimates of Future Warming.](#) Preprint, ESS Open Archive, version 2, 2 June 2026.
- ¹⁵ Pan, Y., Cheng, L. et al. (2026). [Ocean Heat Content Sets Another Record in 2025.](#) Advances in Atmospheric Sciences.
- ¹⁶ Loeb, N. G. et al. (2024). [Observational Assessment of Changes in Earth's Energy Imbalance Since 2000.](#) Surveys in Geophysics, 45, 1757.
- ¹⁷ Loeb, N. G. et al. (2021). [Satellite and Ocean Data Reveal Marked Increase in Earth's Heating Rate.](#) Geophysical Research Letters, 48, e2021GL093047.
- ¹⁸ Goessling, H. F., Rackow, T. & Jung, T. (2025). [Recent global temperature surge intensified by record-low planetary albedo.](#) Science, 386.
- ¹⁹ Hodnebrog, Ø. et al. (2024). [Recent reductions in aerosol emissions have increased Earth's energy imbalance.](#) Communications Earth & Environment, 5, 166.
- ²⁰ Stevens, B. et al. (2026). [Earth's net incoming energy-flux imbalance and its implications for understanding climate change.](#) Reports on Earth System Science No. 301, Max Planck Institute for Meteorology.
- ²¹ Self, S. et al. United States Geological Survey. [The Atmospheric Impact of the 1991 Mount Pinatubo Eruption.](#)

- ²² Carbon Brief. [Explainer, how human-caused aerosols are masking global warming.](#)
- ²³ Watson-Parris, D. et al. (2025). [Weak surface temperature response to recent reductions in shipping emissions.](#) Atmospheric Chemistry and Physics, 25, 4443.
- ²⁴ Yuan, T. et al. (2024). [Abrupt reduction in shipping emission as an inadvertent geoengineering termination shock produces substantial radiative warming.](#) Communications Earth & Environment, 5, 281.
- ²⁵ Skeie, R. B., Hodnebrog, Ø. & Myhre, G. et al. (2024). [Multi-model effective radiative forcing of the 2020 shipping fuel regulation.](#) Atmospheric Chemistry and Physics, 24, 13361.
- ²⁶ Samset, B. H. et al. (2025). [East Asian aerosol cleanup has likely contributed to the recent acceleration in global warming.](#) Communications Earth & Environment. Published 14 July 2025.
- ²⁷ Hoesly, R. et al. (2024). [Community Emissions Data System \(CEDS\), global sulphur dioxide emissions, presented via Our World in Data.](#)
- ²⁸ Park, S. & Soden, B. (2025). [Negligible contribution from aerosols to recent trends in Earth's energy imbalance.](#) Science Advances. Published 28 November 2025.
- ²⁹ Ceppi, P. et al. (2026). [Emerging low-cloud feedback and adjustment in global satellite observations.](#) Atmospheric Chemistry and Physics, 26, 4153.
- ³⁰ Tselioudis, G. et al. (2025). [Contraction of the World's Storm-Cloud Zones the Primary Contributor to the 21st Century Increase in the Earth's Sunlight Absorption.](#) Geophysical Research Letters.
- ³¹ The Economist (2026). [The rate at which Earth is absorbing energy is alarming scientists.](#) Science and technology section, 15 July 2026. Print edition of 18 July 2026 under the headline "Reflections on a warming planet". Attributed to Oliver Morton, planetary affairs editor.
- ³² Hansen, J. & Kharecha, P. (2025). [Large Cloud Feedback Confirms High Climate Sensitivity.](#) Columbia University, 13 May 2025. Not peer-reviewed.
- ³³ MacDougall, A. H. et al. and the Zero Emissions Commitment Model Intercomparison Project. [Review of the zero emissions commitment.](#) Frontiers in Science, 2023.
- ³⁴ Minobe, S., Behrens, E., Findell, K. L., Loeb, N. G., Meyssignac, B. & Sutton, R. (2025). [Global and regional drivers for exceptional climate extremes in 2023–2024: beyond the new normal.](#) npj Climate and Atmospheric Science, 8, 138. Published 7 April 2025.
- ³⁵ Tsuchida, K., Kosaka, Y. & Minobe, S. (2026). [Multi-year La Niña to El Niño transition influenced Earth's extreme energy uptake in 2022–2023.](#) Nature Geoscience, 19. Published 12 February 2026.
- ³⁶ Zheng, J. et al. (2026). [Global mean sea level budget and its acceleration.](#) Science Advances, 12(21). Published 20 May 2026.
- ³⁷ IPCC (2021). [Summary for Policymakers. In: Climate Change 2021: The Physical Science Basis. Contribution of Working Group I to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change.](#) Cambridge University Press.
- ³⁸ University of Exeter and partners (2025). [Global Tipping Points Report 2025.](#) Published 13 October 2025.
- ³⁹ Armstrong McKay, D. I. et al. (2022). [Exceeding 1.5C global warming could trigger multiple climate tipping points.](#) Science, 377, eabn7950.
- ⁴⁰ Loeb, N. G. (2026). [State of CERES, Spring 2026.](#) Presentation to the CERES Science Team Meeting, NASA Langley Research Center, 12–14 May 2026.
- ⁴¹ NASA (2026). [Terra: The End of an Era.](#) NASA Earth Science mission page.
- ⁴² NASA (2026). [Fiscal Year 2027 Budget Request.](#) Published April 2026.

⁴³ IPCC (2026). [IPCC Working Group I AR7 First Order Draft expert review](#). Announced 6 July 2026.

⁴⁴ IPCC (2026). [Sixty-fourth Session of the IPCC, Bangkok, 24–27 March 2026](#).

⁴⁵ Carbon Brief (2026). [Ongoing failure to agree AR7 timeline is unprecedented in IPCC history](#).

⁴⁶ Center for International Environmental Law (2026). [Solar geoengineering developments, spring 2026](#).





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