In the

INTERNATIONAL TRIBUNAL FOR THE LAW OF THE SEA

Case No. 31

Responsibilities and Obligations of States with Respect to Climate Change and International Law

Request for Advisory Opinion Submitted to the Tribunal by the Commission of Small Island States

AMICUS CURIAE SUBMISSION

16 JUNE 2023

Submitted by:

Our Children's Trust
ourchildrenstrust.org
Amsterdam, Netherlands

Oxfam International
oxfamamerica.org
Washington D.C., U.S.A.

On behalf of:

Nathan Baring	23 years old	Alaska, United States
Tyrique Bowles	16 years old	Virginia, United States
Levi Draheim	15 years old	Florida, United States
Giovanna Finley-Brook	15 years old	Virginia, United States
India Fehely Grace	22 years old	Washington, United States
Zoe Grames-Webb	16 years old	British Columbia, Canada
Layla Hasanzadah	18 years old	Virginia, United States
Tia M. Hatton	26 years old	Oregon, United States
Bodhi K.	13 years old	Washington, United States
Rylee Brooke Kamahele	15 years old	Hawai’i, United States
Cecilia La Rose	19 years old	Ontario, Canada
Madeline Laurendeau	21 years old	Manitoba, Canada
Katerina Leedy	19 years old	Virginia, United States
Alex Loznak	26 years old	Oregon, United States
Kawahine’ilikea Naehu	13 years old	Hawai’i, United States
Miriam Oommen	26 years old	Oregon, United States
Griffin Plush	26 years old	Alaska, United States
Cadence Rubin	11 years old	Virginia, United States
Claudia Sachs	20 years old	Virginia, United States
Sophia Sidarous	21 years old	Nova Scotia, Canada
Sáj Starcevich	17 years old	Saskatchewan, Canada
Cade Emory Terada	24 years old	Alaska, United States
Sadie Vipond	17 years old	Alberta, Canada
Lauren Kate Wright	19 years old	Saskatchewan, Canada

For Correspondence
Kelly Matheson, Our Children’s Trust
Looiersgracht 98, 1016VT, Amsterdam, Netherlands
kelly@ourchildrenstrust.org | +31 6 39.35.65.27

Amicus Curiae Submission

Table of Contents

I. Introduction

State Parties to the United Nations Convention on the Law of the Sea ("Convention") have an explicit obligation "to protect and preserve the marine environment."[1] This general requirement incorporates specific duties to take all measures "necessary to prevent, reduce, and control pollution of the marine environment from any sources,"[2] including "[p]ollution from or through the atmosphere."[3]

Voluminous and ever-increasing scientific evidence demonstrates that human-induced climate change is having catastrophic impacts on the stability of the oceans as well as on the long-term viability of many marine ecosystems. This ecological harm leads to substantial injuries to human populations around the world. It is paramount that the International Tribunal on the Law of the Sea ("Tribunal") consider this mounting scientific evidence carefully when deliberating on the advisory request submitted by the Commission of Small Island States with regard to the obligations of State Parties under the Convention in the context of climate change.

Importantly, crucial scientific evidence regarding the true nature of climate change is frequently obscured by the politically determined targets specified in Article 2(1) of the Paris Agreement which are aimed at "[h]olding the increase in global average temperature to well below 2°C above pre-industrial levels and pursuing efforts to limit the temperature increase to 1.5°C above pre-industrial levels[]"[4] ("Paris temperature targets"). The Paris Agreement itself expressly recognizes that an effective response to the urgent threat of climate change must be based on "the best available scientific knowledge,"[5] yet it adopts temperature targets that are not scientifically based and that are insufficient to protect and preserve oceans and marine environments.

Rather than relying on temperature targets, prominent climate scientists indicate that the level of atmospheric carbon dioxide is vastly superior to determine the health and stability of the climate system. Specifically, scientists look to the current state of Earth's energy imbalance. Earth's energy imbalance is a measure of the difference between energy coming into Earth's atmosphere from solar radiation and the energy being released back out to space. Because of excessive atmospheric greenhouse gases, more energy is coming into Earth's atmosphere than is going out, leading to an energy imbalance that is causing global warming and climate change more generally. Scientists refer to Earth's energy imbalance as the "most critical" metric for determining whether actions to combat climate change are working. Only when levels of atmospheric carbon dioxide ("CO_2") are returned from their current level of 419 parts per million ("ppm") in 2022 back down to approximately 350 ppm will balance in Earth's energy system be restored, thereby protecting and preserving oceans and marine environments.

This advisory opinion is critical because most (~90%) of the heat accumulating in Earth's energy system is being stored in the oceans, which act as a natural sink for excess heat energy. This excess heat is leading to dramatic consequences, including the rapid melting of sea ice in the Arctic which has corollary impacts throughout Earth's oceans. Essentially, oceans act as a natural

[1] Convention on the Law of the Sea, Dec. 10, 1982, 1833 U.N.T.S. 397, Art. 192 [hereinafter Convention].
[2] *Id.* at Art. 194.
[3] *Id.* at Art. 212.
[4] Paris Agreement to the United Nations Framework Convention on Climate Change, Dec. 12, 2015, 3156 U.N.T.S. 54113, Art. 2 § 1(a), https://unfccc.int/sites/default/files/english_paris_agreement.pdf [hereinafter Paris Agreement].
[5] *Id.* at Preamble.

regulator of Earth's energy and climate systems, but they are being stretched far beyond capacity in that function.

Simply put, we are already in an overshoot scenario by about 70 ppm atmospheric CO_2. In turn, urgent State action is required to reduce greenhouse gas pollution to avoid further harm to the oceans and marine environments. Although time is short, pathways to achieve rapid reductions in line with the 350 ppm limit exist and are technologically feasible. State failure to rapidly come into compliance with this standard amounts to a violation of their obligations under the Convention given the resulting failure to protect and preserve oceans and marine environment as well as the communities that rely on oceans for their lives and livelihoods.

II. Summary of *Amicus Curiae* Submission

To abide by their obligations and duties under the Convention, State Parties must reduce their greenhouse gas pollution producing activities in accordance with what the most up-to-date and best available scientific evidence indicates is necessary to stabilize Earth's current energy imbalance. For purposes of this *amicus curiae* submission, "best available science" means the most up-to-date science that i) maximizes the quality, objectivity, and integrity of information, including statistical information; ii) uses multiple peer-reviewed and publicly available data; and iii) clearly documents and communicates risks and uncertainties in the scientific basis for its conclusions. This is particularly relevant in a field such as climate science in which new data are constantly emerging and helping to further clarify the enormous impacts that degradation of the environment—including our oceans and marine ecosystems—is having on human rights. Accordingly, the purpose of this submission is to present the Tribunal with a summary of the best available evidence within the field of climate science that is relevant to the legal questions before the Tribunal. Scrutiny of this evidence provides a sound evidentiary basis upon which to make the findings set forth in Section VI.

A. The 1.5°C and 2°C temperature targets specified in the Paris Agreement do not protect oceans and marine environments

Too often, the non-science based and outdated Paris temperature targets have been presented improperly to courts and tribunals as the best scientific evidence and the *de facto* legal standard for compliance with international legal principles and obligations. This assertion is not supported by scientific evidence or endorsed by scientific bodies.

To the contrary, as discussed in detail in Section III of this submission, leading climate scientists and bodies, including the Intergovernmental Panel on Climate Change ("IPCC"), consistently state that allowing the Earth to heat up to 1.5°C or more above pre-industrial levels is categorically dangerous for the protection and preservation of Earth's oceans and marine environments, not to mention the human populations who rely upon them for survival.[6] Allowing

[6] *See, e.g.*, Intergovernmental Panel on Climate Change, *Global Warming of 1.5°C: An IPCC Special Report on the Impacts of Global Warming of 1.5°C Above Pre-industrial Levels and Related Global Greenhouse Gas Emission Pathways, in the Context of Strengthening the Global Response to the Threat of Climate Change, Sustainable Development, and Efforts to Eradicate Poverty* 445, 447 (Valérie Masson-Delmotte et al. eds., 2019), https://www.ipcc.ch/site/assets/uploads/sites/2/2022/06/SR15_Full_Report_LR.pdf [hereinafter *IPCC Special*

such dangerous levels of planetary warming is expressly incompatible with States' obligations under the Convention to protect and preserve the marine environment as well as their obligations to take measures "to prevent, reduce, and control pollution of the marine environment from or through the atmosphere."[7]

The Paris Agreement is an important and relevant achievement of international negotiation and cooperation, but scrutiny of the Paris temperature targets shows that these targets were not derived from the best available science when they were first formulated in 2015.[8] Instead, they reflect the best political consensus that States were able to reach at the time. A continuous stream of further scientific studies has only reinforced their inadequacy to prevent catastrophic climate outcomes in the intervening years. Furthermore, almost eight years have passed since the Paris Agreement was negotiated. In that time, the scientific evidence indicating the immense dangers of allowing global heating to continue up to—and then remain at—the Paris temperature targets continues to become more robust. As such, the Paris temperature targets would be a flawed reference point for determining State compliance with their obligations under the Convention. Just as a surgeon would not use obsolete medical science that was subject to political compromise while performing a surgical procedure on a patient, courts must not rely upon negotiated and outdated targets when adjudicating cases with wide-ranging impacts on the survival and stability of oceans, marine environments, and the communities that rely on them.

B. Scientists indicate that Earth's energy imbalance is the "most critical" metric for determining whether actions to combat climate change are working

Instead of focusing on temperature targets, this Tribunal should consider what is scientifically necessary to stabilise the Earth's current energy imbalance when defining States' obligations under the Convention. The energy imbalance concept is what climate scientists describe as the "*most critical*" metric for determining "the prospects for continued global warming and climate change."[9]

Earth's energy imbalance is driven by elevated atmospheric concentrations of greenhouse gases—mainly CO_2 measured in ppm[10]—that are produced by human activities, particularly fossil fuel combustion. Atmospheric CO_2 concentration reached 419 ppm in 2022 and will be greater than 420 ppm in 2023 according to the U.S. National Oceanic and Atmospheric Administration,

Report on 1.5°C] ("Warming of 1.5°C is not considered 'safe' for most nations, communities, ecosystems and sectors and poses significant risks to natural and human systems as compared to the current warming of 1°C (*high confidence*). . . . Some of the worst impacts . . . are expected to be felt among agricultural and coastal dependent livelihoods[.]").

7 Convention, *supra* note 1, at Arts. 192, 212.

8 *See* Andrea Rodgers et al., *The Injustice of 1.5˚C–2˚C: The Need for a Scientifically Based Standard of Fundamental Rights Protection in Constitutional Climate Change Cases*, 40 Va. Env't L. J. 102 (2022).

9 Karina von Schuckmann et al., *Heat Stored in the Earth System: Where Does the Energy Go?*, 12 Earth Sys. Sci. Data 2013, 2014 (2020) (emphasis added).

10 In this context, the term "parts per million" ("ppm") signifies "the number of carbon dioxide molecules per million molecules of dry air[]" based on "measurements [] from the mid-troposphere, [i.e.,] the layer of Earth's atmosphere that is 8 to 12 kilometers [] above the ground." Holly Shaftel et al., *Carbon Dioxide*, NASA Global Climate Change: Vital Signs Planet (Nov. 22, 2022), https://climate.nasa.gov/vital-signs/carbon-dioxide/.

crossing the halfway point towards doubling atmospheric CO_2 from its pre-industrial concentration.[11]

Scientific consensus indicates that to restore the stability of Earth's climate so as to protect the oceanic systems upon which human life and health depend, States must reduce atmospheric concentrations of CO_2 to at least an environmentally sustainable level of 350 ppm ("350 ppm limit").[12] To achieve this limit, at minimum, ongoing CO_2 pollution must be drastically reduced and existing atmospheric CO_2 must be removed[13] to prevent the worsening of the unprecedented climate disasters the world has experienced in the last few decades,[14] such as the deterioration of fisheries important for global food supplies, rising ocean acidification, increased coastal flooding due to sea level rise, and the accelerating loss of coral reefs. The laws of physics make clear that restoring the stability of Earth's energy and climate system by significantly reducing the concentration of CO_2 in the atmosphere is the only way to safeguard the stability of the oceans and the viability of numerous marine ecosystems in keeping with State Parties' obligations under the Convention.[15]

Importantly, the concept of Earth's energy imbalance reflects the gravity and urgency of the current climate crisis more accurately than do the Paris temperature targets. Global average

---

[11] Dr. Pieter Tans & Dr. Ralph Keeling, *Trends in Atmospheric Carbon Dioxide: Data*, NOAA Global Monitoring Lab., https://gml.noaa.gov/ccgg/trends/data.html; *see* the NOAA data available at the following website: https://gml.noaa.gov/webdata/ccgg/trends/co2/co2_annmean_mlo.txt; *see also*, https://www.noaa.gov/news-release/broken-record-atmospheric-carbon-dioxide-levels-jump-again

[12] *See, e.g.*, Expert Report of James E. Hansen, Ph.D., *Juliana v. United States*, 339 F. Supp. 3d 1062, No. 6:15-cv-01517-TC (D. Or. Jun. 28, 2018), ECF No. 274-1, at 3, http://climatecasechart.com/wp-content/uploads/sites/16/case-documents/2018/20180628_docket-615-cv-1517_exhibit-7.pdf [hereinafter Hansen Expert Report]; James Hansen et al., *Target Atmospheric CO_2: Where Should Humanity Aim*, 2 The Open Atmospheric Sci. J. 217, 217 (2008), https://openatmosphericsciencejournal.com/contents/volumes/V2/TOASCJ-2-217/TOASCJ-2-217.pdf [hereinafter *Target Atmospheric CO_2*]; von Schuckmann et al., *supra* note 9, at 2029 (mentioning that "[t]he amount of CO_2 in the atmosphere would need to be reduced from 410 to 353 ppm to . . . bring[] Earth back towards energy balance").

[13] Although more GHGs contribute to climate change than just CO_2, CO_2 is by far the largest forcer of climate change amongst the various GHGs. Other GHGs such as nitrous oxide (N_2O) play a relatively minor role in causing planetary heating and are difficult to reduce due to their association with modern food production. Still other GHGs, such as methane (CH_4), eventually break down to atmospheric CO_2 and are therefore accounted for in the atmospheric CO_2 metric. Given these considerations, many scientific studies turn to CO_2 concentrations in the atmosphere as a useful metric that is directly correlated with, and therefore accurately indicates, the extent of Earth's energy imbalance and global warming. *See* Richard Allan et al., *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 7, 28 (Valérie Masson-Delmotte et al. eds., 2021), https://www.ipcc.ch/report/ar6/wg1/downloads/report/IPCC_AR6_WGI_SPM.pdf (noting the "near-linear relationship between the cumulative CO_2 emissions and global warming" without mentioning any other GHGs); von Schuckmann et al., *supra* note 9 at 2029 ("[S]ome continuing increase in N_2O, whose emissions are associated with food production, seems inevitable, so there is little prospect for much net reduction of non-CO_2 greenhouse gases, and thus the main burden for climate stabilization falls on CO_2 reduction."); Martin Wahlen, *The Global Methane Cycle*, 21 Annu. Rev. Earth Planet Sci. 407, 407 (1993), https://adsabs.harvard.edu/pdf/1993AREPS..21..407W (noting that atmospheric methane ultimately breaks down into carbon dioxide and water after 8-12 years).

[14] *See, e.g.*, James Hansen et al., *Young People's Burden: Requirement of Negative CO_2* Emissions, 8 Earth Sys. Dynamics 557, 595 (2017), https://esd.copernicus.org/articles/8/577/2017/ [hereinafter *Young People's Burden*] ("We conclude that the world has already overshot appropriate targets for GHG amount and global temperature, and we thus infer an urgent need for (1) rapid phasedown of fossil fuel emissions, (2) actions that draw down atmospheric CO2, and (3) actions that, at minimum, eliminate net growth of non-CO_2 climate forcings.").

[15] *See* Convention, *supra* note 1, at Art. 194.

surface temperatures have already reached ~1.1°C–1.3°C above pre-industrial levels[16] which can give the erroneous impression that an unused 'budget' remains for States to continue safely emitting CO_2 before the Paris temperature target of 1.5°C is reached. By contrast, measurements of atmospheric CO_2 have already reached 419 ppm, substantially overshooting the 350 ppm limit.

The consequence of this overshoot is that humanity is already immersed in a climate emergency. An ever-growing body of science verifies the devastating outcomes: coral reef loss, melting ice sheets and glaciers, and sea-level rise are all made more frequent and severe by climate change, resulting in the loss of property, forced migration, food and water shortages, poverty, violence, disease, and death.[17] The science is clear that the only way to minimize these extreme dangers posed to oceans, marine environments, and human life and well-being from climate change is to stabilise Earth's energy imbalance by bringing atmospheric CO_2 concentration back down to 350 ppm.[18]

C. Urgent State action is required to avoid further harm

States have already overshot safe and stable levels of atmospheric CO_2, putting humanity at serious risk.[19] However, there remains a narrow window of opportunity to bring such dangerous amounts of atmospheric CO_2 back down to levels that protect and preserve the ocean and marine environments by the end of the century.[20] Immediate action is required to limit the damage which has already been done and which will continue to accumulate for many years to come. Scientific evidence emphatically establishes that the necessary way for States to achieve the 350 ppm limit,

---

[16] The indeterminacy of global average temperature rise is one of the reasons temperatures make a poor metric for evaluating the extent of global warming. For purposes of this submission, intervenors will use ~1.1°C–1.3°C of average global temperature rise above pre-industrial levels noting that ongoing temperature analysis by NASA determines that Earth has warmed "by at least 1.1° Celsius (1.9° Fahrenheit) since 1880[,]" whereas a separate study by Berkeley Earth states that the Earth has warmed by 1.3°C. The IPCC indicates a "likely range of total human-caused global surface temperature increase" of 0.8°C to 1.3°C. Such discrepancies make it difficult to determine whether and when global temperature targets may have been breached. Measurements of atmospheric CO_2 are much more precise. *See* Paul Przyborski, *World of Change: Global Temperatures*, NASA Earth Observatory (2022), https://earthobservatory.nasa.gov/world-of-change/global-temperatures; Berkeley Earth, *The World Has Warmed 1.3°C*, (2022), https://berkeleyearth.org/; Allan et al., at 5.

[17] *See generally* Stephen Ornes, *How Does Climate Change Influence Extreme Weather? Impact Attribution Research Seeks Answers*, 115 Proc. Nat'l Acad. Sci. 8232 (2018), https://www.pnas.org/doi/epdf/10.1073/pnas.1811393115.

[18] *See, e.g.*, Nico Wunderling et al., *Global Warming Overshoots Increase Risks of Climate Tipping Cascades in a Network Model*, 13 Nature Climate Change 75 (2022), https://www.nature.com/articles/s41558-022-01545-9; Johan Rockström et al., *Safe and Just Earth System Boundaries*, Nature 1,3 (2023) https://www.nature.com/articles/s41586-023-06083-8; David I. Armstrong McKay et al., *Exceeding 1.5°C Global Warming Could Trigger Multiple Climate Tipping Points*, 377 Science 1171, 1179 (2022); von Schuckmann et al., *supra* note 9, at 2014; *Young People's Burden*, *supra* note 14 at 578.

[19] *See, e.g.*, *Young People's Burden*, *supra* note 14, at 595 ("We conclude that the world has already overshot appropriate targets for GHG amount and global temperature[.]").

[20] *See generally* Mark Jacobson, *Low-cost Solutions to Global Warming, Air Pollution, and Energy Insecurity for 145 Countries*, Energy & Env't Sci., 15, 3343, 3344 (2022), https://web.stanford.edu/group/efmh/jacobson/Articles/I/145Country/22-145Countries.pdf [hereinafter *Low-cost Solutions for 145 Countries*] ("The world needs a rapid transition to clean, renewable energy to address air pollution, climate, and energy security issues. Here, roadmaps to transition 145 countries to 100% clean, renewable WWS energy and storage across all energy sectors are developed. The full transition should occur no later than 2050, but ideally by 2035, with no less than 80% by 2030.").

thereby "restor[ing] planetary energy balance[,]" is by rapidly phasing out fossil fuel pollution and drawing down atmospheric CO_2.[21] Conversely, many States are currently not only failing to do these two action items but they are also bringing additional fossil fuel infrastructure projects online under the erroneous belief that the resulting increased pollution will not threaten the world's ability to remain in-line with the Paris temperature targets and prevent catastrophic climate change. The truth is the longer States take to cease developing fossil fuel infrastructure, to substantially reduce existing fossil fuel pollution, and to remove the excess CO_2 already present in the atmosphere, the greater the magnitude and severity of the harms to marine environments that will come to pass due to climate change.[22] The 350 ppm limit is much better equipped to accurately convey this urgency than the Paris temperature targets as the latter gives the erroneous perception that more CO_2 pollution can be emitted without causing harm to the planet.

According to pathway scenarios developed by scientific experts in climate modelling, it remains possible for ambitious greenhouse gas pollution reduction and drawdown of atmospheric CO_2 to make our current overshoot of the 350 ppm limit only temporary rather than permanent. It is still possible to bring the steady increase of atmospheric CO_2 concentrations to a peak, followed by a slow but steady decrease that will significantly reduce the impacts of climate changes over the coming decades and centuries.[23] However, States' current policies, actions, and international commitments are inadequate—both in urgency and in scope—to accomplish this goal. Indeed, many States' pro-fossil fuel policies undermine the achievement of this already too-high and unsafe target.[24] As discussed in Section III, the longer States take to sufficiently address the climate crisis, the greater the risks that irreversible climate tipping points will be triggered, initiating irreversible runaway heating,[25] rendering vast regions of the world "uninhabitable[,]"[26] and

---

[21] *See e.g.,* James Hansen 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*, 16 Atmospheric Chemistry & Physics 3761, 3801 (2016) https://acp.copernicus.org/articles/16/3761/2016/acp-16-3761-2016.pdf [hereinafter *Ice Melt, Sea Level Rise and Superstorms*].

[22] *See Young People's Burden*, *supra* note 14, at 577 ("If phasedown of fossil fuel emissions begins soon, improved agricultural and forestry practices, including reforestation and steps to improve soil fertility and increase its carbon content, may provide much of the necessary CO_2 extraction. In that case, the magnitude and duration of global temperature excursion above the natural range of the current interglacial (Holocene) could be limited and irreversible climate impacts could be minimized. In contrast, continued high fossil fuel emissions today place a burden on young people to undertake massive technological CO_2 extraction if they are to limit climate change and its consequences.").

[23] James Hansen, *Dangerous Human-made Interference with Climate: a GISS ModelE Study*, 7 Atmos. Chem. Phys. 2287, 2306 (2007), https://acp.copernicus.org/articles/7/2287/2007/acp-7-2287-2007.pdf.

[24] *See* Hansen Expert Report, *supra* note 12, at 19 (noting that the U.S. federal government supports "even the development of unconventional sources of fossil fuels despite the fact that these 'unconventional' fossil fuels are even more carbon-intensive than conventional oil and gas and are thus more harmful to the climate[]"); s*ee also*, United Nations, Climate Change, *Climate Plans Remain Insufficient: More Ambitious Action Needed Now*, U.N. Climate Change News (2022), https://unfccc.int/news/climate-plans-remain-insufficient-more-ambitious-action-needed-now (noting that "the combined climate pledges of 193 Parties under the Paris Agreement could put the world on the track for around 2.5 degrees Celsius of warming by the end of the century[]" despite all Parties agreeing to aim for 1.5 or 2.0 degrees of warming. In fact, a recent U.N. report shows that Parties' cumulative "current commitments will increase emissions by 10.6% by 2030, compared to 2010 levels.").

[25] S*ee* Will Steffen, et al., *Trajectories of the Earth System in the Anthropocene*, 115:33 Proc. Nat'l Acad. Sci. 8252 (2018), https://www.pnas.org/doi/full/10.1073/pnas.1810141115.

[26] S*ee* Stockholm Resilience Centre, *Earth at Risk of Heading Towards "Hothouse Earth" State*, Sci. Daily (Aug. 6, 2018), https://www.sciencedaily.com/releases/2018/08/180806152040.htm (quoting co-author of study published in

undermining the effectiveness of legal remedies. Given this urgency, specific and time-bound State action underpinned by scientific rather than non-science-based and outdated targets must commence immediately.

D. The Tribunal has the opportunity and authority to make relevant determinations in these proceedings

In the face of these grave concerns, the Tribunal is warranted to make the following determinations:

a. State obligations under the Convention to "protect and preserve the marine environment[;]"[27] to take "all measures consistent with the Convention that are necessary to prevent, reduce or control pollution of the marine environment from any source[;]"[28] and, particularly, "to adopt laws and regulations to prevent, reduce and control pollution of the marine environment from or through the atmosphere"[29] encompass the duty to stabilize Earth's climate system.
b. States' actions to address human-caused climate change must be based on the best available scientific evidence which indicates that restoring Earth's energy balance will require States to pursue pathways to reduce atmospheric CO_2 concentrations from current levels to 350 ppm as rapidly as possible.
c. States whose laws, policies, and commitments are not aligned with achieving the 350 ppm limit must take specific, immediate, and adequate measures to phase out emissions of CO_2 and other greenhouse gas pollution and to remove CO_2 from the atmosphere as necessary to stabilise the climate system for the protection and preservation of marine ecosystems and the ocean as a whole.
d. Certain populations, including children of Small Island States, coastal-communities, and Arctic populations, are particularly at risk due to the impacts of human-caused climate change, and State failures to reduce greenhouse gas pollution and atmospheric CO_2 in accordance with the best available climate science put those populations at increased risk of harm from subsequent deterioration to the marine environment and long-standing oceanic systems.
e. State Parties are liable under Articles 139 and 235 for the damage caused by their failures to "protect and preserve the marine environment"[30] in the context of climate change.

To aid the Tribunal in its deliberations, this submission contains the following components. Section III provides a survey of scientific evidence from relevant peer-reviewed studies and reports that corroborate the arguments contained in the submission. Section IV briefly addresses the misalignment between the Paris temperature targets and the 350 ppm limit. Section V indicates the applicability of the best available climate science to the Convention as well as other applicable

---

the Proceedings of the National Academy of Sciences); *see also* David Wallace-Wells, *The Uninhabitable Earth: Life After Warming* (2019).
[27] Convention, *supra* note 1, at Art. 192.
[28] *Id.* at Art. 194.
[29] *Id.* at Art. 212.
[30] *Id.* at Art. 192.

international legal principles and treaties. Finally, Section VI discusses the remedies available to this Tribunal in the context of climate change. Intervenors have also included "Annex I," which provides a curated bibliography of the most critical studies and source material cited with short synopses and hyperlinks. Copies of any of the other source materials relied upon in this submission as well as further information regarding the qualifications of many of the cited scientific experts can be provided upon request. In addition, OCT and Oxfam, the organizations that are filing this submission in conjunction with the undersigned young people, request the opportunity to provide in-person testimony in order to clarify and respond to any questions the Tribunal may have.

III. Best Available Scientific Evidence and Findings

Scientists have long known that climate change is causing severe and potentially irreversible alterations to oceanic systems and marine habitats, and the principles of physics and chemistry that underlie climate change are elementary and long understood.[31] CO_2 and other greenhouse gases absorb solar energy being reflected off the Earth's surface that would otherwise go back into outer space. Without these naturally occurring greenhouse gases, Earth would be freezing.[32] However, as greenhouse gases accumulate in the atmosphere over time from human emissions, Earth warms, leading to severe climate instability. By analogy, CO_2 and other greenhouse gases act like a blanket around the Earth, trapping energy inside our atmosphere.[33] As more and more heat is trapped, Earth's energy becomes imbalanced, which results in rising global temperatures that melt snowpack, glaciers, ice sheets, and sea ice and that cause heatwaves, sea-level rise, and extreme events such as storms, floods, drought, and wildfires. This results in disruptions to oceanic systems, food and water shortages, public health crises, epidemics, mass migration, higher incidence of disease, loss of property, and more.

Recent studies have substantially fine-tuned this knowledge, clarifying the urgency with which we must act to preserve Earth's marine ecosystems in order to protect the billions of people who depend on the stability and health of the oceans. In particular, up-to-date scientific research consistently makes the following conclusions with ever-increasing clarity and precision:

a. Current levels of warming at approximately 1.1°C to 1.3°C are already severely altering the oceans and deteriorating marine environments. Further warming will increase the severity and frequency of those already existent impacts.
b. In particular, allowing continued warming up to a sustained level of 1.5°C above pre-industrial times would fail to protect and preserve oceans, marine ecosystems and, in turn, human rights.
c. Allowing global average surface temperatures to remain elevated at current levels, let alone levels of 1.5°C (or more) above pre-industrial times, could trigger multiple climate tipping points impacting oceans and marine environments.

---

[31] University Corporation for Atmospheric Research: Centre for Science Education, *History of Climate Science Research* (2022), https://scied.ucar.edu/learning-zone/how-climate-works/history-climate-science-research.
[32] *See* University Corporation for Atmospheric Research: Centre for Science Education, *The Greenhouse Effect* (2022), https://scied.ucar.edu/learning-zone/how-climate-works/greenhouse-effect.
[33] *See* Hansen Expert Report, *supra* note 12, at 10 (describing GHGs as "gases that absorb infrared (heat) radiation and thus act as a blanket that warms the planetary surface[]").

The following subsections provide more context and evidence in support of these scientific conclusions.

A. Current levels of warming at approximately 1.1°C to 1.3°C are already severely altering the oceans and deteriorating marine environments

Scientific research concludes that today the world's oceans and marine ecosystems are being affected by climate harms in myriad ways. This section provides a survey of key research findings at the intersection of climate change and oceans, illustrating the growing scientific consensus that *current* global warming of ~1.1ºC-1.3ºC above pre-industrial levels is already causing significant alterations to the world's oceans and deterioration of marine environments.[34] This damage comes in many forms such as sea-ice retreat, ocean acidification, increased incidence of algal blooms, and marine heatwaves.

Using Arctic sea-ice as a case study, sea-ice retreat is currently leading to compounding harms. In the Barents-Kara region of the Arctic Ocean in particular, sea-ice is rapidly retreating in response to record-setting rates of regional warming[35] due to atmospheric carbon pollution produced by humans.[36] A concurrent increase in atmospheric rivers (i.e., narrow sections of the atmosphere that convey moisture from the equator to the Poles) hitting the Arctic has hindered sea-ice recovery in winter months.[37] Sea-ice area has also reached unprecedented lows in Baffin Bay,[38] southeast Greenland,[39] and the Southern Ocean around Antarctica.[40]

In addition, human-emitted carbon is driving acidification of North Pacific[41] and Chukchi Sea[42] waters, and Arctic sea-ice retreat is leading to Arctic Ocean acidification rates 3 to 4 times greater than other ocean basins.[43] This rapid ocean acidification is the result of excess atmospheric CO_2 dissolving into the ocean, lowering ocean pH, and making the ocean more acidic. Higher acidity of the oceans has numerous consequences for marine ecosystems, in particular for organisms with calcium carbonate shells or exoskeletons such as clams, oysters, mussels, and corals because the pH in the oceans will increase calcium carbonate dissolution. These organisms are essential in countless aquatic food chains, and their inability to thrive can have devastating impacts on marine ecosystems throughout the ocean.

---

[34] Hoesung Lee et al., *Climate Change 2023: Synthesis Report of the IPCC Sixth Assessment Report (AR6) Longer Report* 1, 5 (2023), https://report.ipcc.ch/ar6syr/pdf/IPCC_AR6_SYR_SPM.pdf.
[35] Ketil Isaksen et al., *Exceptional Warming over the Barents Area*, 12:1 Scientific Reports 9371, 9371 (2022).
[36] Yoko Yamagami et al., *Barents-Kara Sea-Ice Decline Attributed to Surface Warming in the Gulf Stream*, 13 Nature Communications 3767, 3767 (2022).
[37] Pengfei Zhang et al., *More Frequent Atmospheric Rivers Slow the Seasonal Recovery of Arctic Sea Ice*, 13 Nature Climate Change 266, 266 (2023).
[38] Thomas J. Ballinger et al., *Abrupt Northern Baffin Bay Autumn Warming and Sea-Ice Loss Since the Turn of the Twenty-First Century*, 49 Geophysical Rsch. Letters 1, 1 (2022).
[39] Mads Peter Heide-Jørgensen et al., *A Regime Shift in the Southeast Greenland Marine Ecosystem*, 29 Global Change Biology 668, 673-674 (2022).
[40] Juhi Yadav et al., *Atmospheric Precursors to the Antarctic Sea Ice Record Low in February 2022*, 4 Env't Rsch. Comm. 1, 1 (2022).
[41] Cheng-long Li et al., *Accelerated Accumulation of Anthropogenic CO_2 Drives Rapid Acidification in the North Pacific Subtropical Mode Water During 1993-2020*, 49:24 Geophysical Rsch. Letters 1, 1 (2022).
[42] Di Qi et al., *Rapid Acidification of the Arctic Chukchi Sea Waters Driven by Anthropogenic Forcing and Biological Carbon Recycling*, 49:4 Geophysical Rsch. Letters 1, 1 (2022).
[43] Di Qi et al., *Climate Change Drives Rapid Decadal Acidification in the Arctic Ocean from 1994 to 2020*, 377 Science 1544, 1546 (2022).

Sea-ice retreat is also facilitating highly toxic and reoccurring algal blooms in the Arctic Ocean near Alaska,[44] and algal blooms are also becoming more frequent and extensive in many other parts of the ocean due to climate change.[45] Algal blooms are not only toxic for humans, they also lead to the consumption of massive amounts of dissolved oxygen in the water by bacteria, leading to dead zones in which aquatic life cannot survive.

Looking next at heatwaves, anthropogenic greenhouse gas pollution has increased marine-heatwave frequency "more than 20-fold" and is like to increase marine-heatwave duration and intensity by the same amount.[46] Higher occurrences of marine heatwaves threaten ecosystems in all ocean basins under the currently warming climate, especially foundational species such as corals, seagrasses, and kelps.[47] In fact, marine heatwaves have grown so extreme that they are now exceeding the adaptive capabilities of corals[48] all while more people (~1 billion in 2020 versus ~762 million in 2000) reside near and depend on coral reefs than at any other time in human history.[49]

In the Mediterranean Sea, heatwaves have driven mass mortality events in every year from 2015 to 2019.[50] Many Mediterranean Sea species are at risk of extinction given today's level of global warming: 90% of the region's protected areas have 4-19 species facing extinction, including sea turtles and marine mammals.[51] As of 2022, bath sponges in the Mediterranean are likely extinct at the population scale.[52] Along southeast Greenland, the loss of sea ice and concurrent ocean warming has resulted in a fundamental change in the marine ecosystem with new species of fish and whales occupying the waters, displacing narwhals and walruses, and consuming greater numbers of prey.[53] Another example of ocean-warming impacts is for eastern United States scallop fisheries, where populations have severely declined in recent decades, culminating in 100% mortality in New York's fishery during the 2020 marine heatwave.[54]

Heatwaves, sea-ice decline, and ecosystem changes all reflect the fact that the world's oceans are holding much of the excess energy from Earth's energy imbalance,[55] which reached a

---

[44] Donald M. Anderson et al., *Evidence for Massive and Recurrent Toxic Blooms of* Alexandrium catenella *in the Alaskan Arctic*, 118 Proceedings Nat'l Acad. Sci. 1, 4 (2021).
[45] Christopher J. Gobler, *Climate Change and Harmful Algal Blooms: Insights and Perspective*, 91 Harmful Algae 1, 1 (2020), https://www.sciencedirect.com/science/article/pii/S1568988319302045.
[46] Charlotte Laufkötter et al., *High-Impact Marine Heatwaves Attributable to Human-Induced Global Warming*, 369 Science 1621, 1621 (2020).
[47] *See* Dan A. Smale et al., *Marine Heatwaves Threaten Global Biodiversity and the Provision of Ecosystem Services*, 9 Nature Climate Change 306 (2019).
[48] Magena R. Marzonie et al., *The Effects of Marine Heatwaves on Acute Heat Tolerance in Corals*, 29 Global Change Biology 404, 405 (2023).
[49] Amy Sing Wong et al., *An Assessment of People Living by Coral Reefs over Space and Time*, 28 Global Change Biology 7139, 7139 (2022).
[50] Joaquim Garrabou et al., *Marine Heatwaves Drive Recurrent Mass Mortalities in the Mediterranean Sea*, 28 Global Change Biology 5708, 5708 (2022).
[51] Anastasia Chatzimentor et al., *Are Mediterranean Threatened Species at High Risk by Climate Change?*, 29 Global Change Biology 1809, 1809 (2023).
[52] Grenier Marie et al., *Mediterranean Marine Keystone Species on the Brink of Extinction*, 29 Global Change Biology 1681, 1681 (2023).
[53] Mads Peter Heide-Jørgensen et al., *A Regime Shift in the Southeast Greenland Marine Ecosystem*, 29 Global Change Biology 668, 668 (2023).
[54] Stephen J. Tomasetti et al., *Warming and Hypoxia Reduce the Performance and Survival of Northern Bay Scallops (*Argopecten irradians irradians*) amid a Fishery Collapse*, 29 Global Change Biology 2092, 2100 (2023).
[55] *See* von Schuckmann et al., *supra* note 9.

new and unprecedented level in 2022.[56] Indeed, this excess energy may now be destabilizing Earth's ice sheets, resulting in multiple meters of sea-level rise over the course of millennia.[57] Greenland is now warmer than it has been in >1,000 years,[58] and its accelerating ice melt has already accounted for "a significant increase in the global mean sea level."[59] Such melting runs the risk of locking in significant sea-level rise,[60] which has already begun to increase in pace at alarming rates[61] and could eventually lead to the crossing of an ice-sheet stability threshold[62] that will lead to large-scale deglaciation of the island.[63] Similarly, the Southern Ocean may have already warmed to a level that will lead to the disappearance of the West Antarctic ice sheet, resulting in meters of sea-level rise.[64]

B. Allowing continued warming up to a sustained level of 1.5°C (or more) above pre-industrial times would fail to protect and preserve oceans and marine ecosystems and, in turn, the human communities that depend upon them

Scientists have been raising the alarm bells that a world with planetary heating of 1.5°C will have disastrous consequences.[65] A 2018 Special Report from the Intergovernmental Panel on Climate Change ("IPCC")—a partnership between scientists and policymakers set up to provide international climate negotiators with regular scientific assessments on climate change[66]—reached the same conclusion:

---

[56] *See* Lijing Cheng et al., *Another Year of Record Heat for the Oceans*, Advances Atmospheric Sci. 963 (2023).
[57] Peter U. Clark et al., *Sea-Level Commitment as a Gauge for Climate Policy*, 8 Nature Climate Change 653, 653 (2018).
[58] M. Hörhold et al., *Modern Temperatures in Central-North Greenland Warmest in Past Millennium*, 613 Nature 503, 505 (2023).
[59] Otosaka et. al., *Mass Balance of the Greenland and Antarctic Ice Sheets from 1992 to 2020*, 15 Earth Syst. Sci. Data 1597, 1598 (2023).
[60] Jason E. Box et al., *Greenland Ice Sheet Climate Disequilibrium and Committed Sea-Level Rise*, 12 Nature Climate Change 808, 808 (2022).
[61] World Meteorological Organization, *State of the Global Climate 2022*, WMO (2023), https://library.wmo.int/index.php?lvl=notice_display&id=22265#.ZEEef-xBzjC (noting that the rate of global mean sea level rise "has doubled" since the 1990s).
[62] *See* Nil Irvalı et al., *A Low Climate Threshold for South Greenland Ice Sheet Demise During the Late Pleistocene*, 117 Proceedings Nat'l Acad. Sciences 190 (2019); Dennis Höning et al., *Mutlistability and Transient Response of the Greenland Ice Sheet to Anthropogenic CO_2 Emissions*, 50 Geophysical Rsch. Letters 1 (2023).
[63] *See* Alberto V. Reyes et al., *South Greenland Ice-Sheet Collapse During Marine Isotope Stage 11*, 510 Nature 525 (2014).
[64] N. R. Golledge et al., *Retreat of the Antarctic Ice Sheet During the Last Interglaciation and Implications for Future Change*, 48 Geophysical Rsch. Letters 1, 1 (2021).
[65] *See* Rodgers et al, *supra* note 8, at 109-110 (noting that IPCC reports have summarized a significant body of science projecting that warming of 1.5°C of 2°C would be catastrophic[]"); *see also*, McKay et al., *supra* note 18; Wunderling et al., *supra* note 18; Rockström et al., *supra* note 18.
[66] *See* IPCC, *Intergovernmental Panel on Climate Change* (2022), https://www.ipcc.ch/ ("The IPCC was created to provide policymakers with regular scientific assessments on climate change, its implications and potential future risks, as well as to put forward adaptation and mitigation options"). As a quasi-political body of volunteer scientists set up to inform the UNFCCC, the IPCC provides guidance that is policy-relevant, but not policy-prescriptive. In keeping with its role, the IPCC has neither endorsed nor recommended 2°C or 1.5°C as a target in any of its reports since it began publishing reports in 1990.

> Warming of 1.5°C is not considered 'safe' for most nations, communities, ecosystems and sectors and poses significant risks to natural and human systems as compared to the current warming of 1°C (*high confidence*). [] The impacts of 1.5°C of warming would disproportionately affect disadvantaged and vulnerable populations through food insecurity, higher food prices, income losses, lost livelihood opportunities, adverse health impacts and population displacements (*medium evidence, high agreement*). [] Some of the worst impacts on sustainable development are expected to be felt among agricultural and coastal dependent livelihoods, [I]ndigenous people, children and the elderly, poor labourers, poor urban dwellers in African cities, and people and ecosystems in the Arctic and Small Island Developing States (SIDS) (*medium evidence, high agreement*).[67]

The IPCC's Sixth Assessment Report (2021-2023) details what U.N. Secretary General, António Guterres called "an atlas of human suffering."[68] A similarly comprehensive list of scientific findings detailing the climate injuries that will occur specifically at 1.5°C of global warming is beyond the scope of this submission. Instead, the following examples from peer-reviewed studies illustrate the stakes for our oceans and marine environment as well as the human communities that depend on them with a particular focus on Small Island States and Arctic communities, in a world of 1.5°C global heating. At 1.5°C:

- An ice-free Arctic Ocean will likely occur in some September months.[69]
- The Arctic is projected to switch from snow- to rain-dominated in summer and autumn months, further accelerating sea ice melt and causing devastating impacts for the tundra ecosystem.[70]
- Ice-mass loss from Antarctic ice sheets will continue throughout the 21st century with attendant contributions to sea level rise.[71]
- Global glacier and ice-sheet mass loss could contribute >0.5 metres ("m") to global mean sea level rise[72] with an additional 0.2 m of sea-level rise by 2100 due to thermal expansion.[73]
- Large parts of the Arctic Ocean will become too acidic for several months out of the year for animals to build aragonite shells and skeletons.[74]
- The number of marine heatwave days will double.[75]

---

67 *IPCC Special Report on 1.5°C*, *supra* note 6, at 44.
68 Seth Borenstein, *UN Climate Report: "Atlas of Human Suffering" Worse, Bigger,* AP News (February 28, 2022), https://apnews.com/article/climate-science-europe-united-nations-weather-8d5e277660f7125ffdab7a833d9856a3.
69 Uta Kloenne et al., *Only Halving Emissions by 2030 Can Minimize Risks of Crossing Cryosphere Thresholds*, 13 Nature Climate Change 9, 10 (2023).
70 Michelle R. McCrystall et al., *New Climate Models Reveal Faster and Larger Increases in Arctic Precipitation than Previously Projected*, 12 Nature Comm. 6765, 6765 (2021).
71 Robert M. DeConto et al., *The Paris Climate Agreement and Future Sea-Level Rise from Antarctica*, 593 Nature 83, 94 (2021).
72 Tamsin L. Edwards et al., *Projected Land Ice Contributions to Twenty-First-Century Sea Level Rise*, 593 Nature 74, 85 (2021).
73 Matthias Mengel et al., *Committed Sea-Level Rise Under the Paris Agreement and the Legacy of Delayed Mitigation Action*, 9 Nature Comm. 601, 605 (2018).
74 Kloenne et al., *supra* note 69, at 9.
75 Thomas Frölicher et al., *Marine Heatwaves Under Global Warming*, 560 Nature 360, 360 (2018).

- Extreme marine heatwaves that occurred once every hundreds to thousands of years in the pre-industrial period will become decadal to centennial events.[76]
- Only 0.2% of the world's reefs will have thermal refugia from heatwave bleaching.[77]
- Southern Ocean krill stock will decline, threatening the survival of local humpback whales.[78]
- The projected long-term rise in sea level will be 2.5-5 m, with global mean sea level continuing to rise for many millennia to come.[79]
- Around half the world's coastlines will experience what was once a 1-in-100-years extreme sea-level event at least once a year well before the end of this century.[80]
- Up to 88 million people per year will be exposed to coastal flooding with the largest impacted populations located in South Asia and East Asia.[81]

It should be noted that recent acquisition of new elevation data shows that the area of the world's coastlines that is susceptible to flooding with just 1 to 2 m of sea-level rise is more than double what had been previously documented, likely making the above noted area and population impacted by sea-level rise minimum estimates.[82] It should be further noted that, at 2.0°C of warming, the impacts and injuries will be significantly worse on almost every metric.[83]

Sea level rise will be especially devastating for low-lying island states around the world. Although sea-level rise adaptation planning processes often look at inundation statistics, roads and buildings are impacted by high tide flooding before they are fully inundated. With this in mind, OCT's in-house scientists looked at mean higher high water ("MHHW") levels under different sea-level rise scenarios to determine how roads and buildings would be impacted in Antigua & Barbuda, and in Tuvalu. Mean higher high water is the average height of all the daily "higher high water" levels (i.e., the higher of the two high water marks for each tidal day) recorded over a 19-year period. MHHW data for Antigua & Barbuda was obtained from National Oceanic Atmospheric Administration ("NOAA") and MHHW for Tuvalu was retrieved from University of Hawaii Sea Level Center. Road and building data were sourced from OpenStreetMap. Digital elevation models ("DEMs") from Climate Central were used to determine the area impacted by MHHW under different amounts of sea-level rise. It should be noted that there are limitations to these data and to the results due to the low-resolution of the DEMs, incompleteness of the OpenStreetMap database, and the spatiotemporal variability of rising high tides. The following

[76] Charlotte Laufkötter et al., *High-Impact Marine Heatwaves Attributable to Human-Induced Global Warming*, 369 Science 1621, 1621 (2020).
[77] Adele M. Dixon et al., *Future Loss of Local-Scale Thermal Refugia in Coral Reef Ecosystems*, 1 PLOS Climate 1, 4 (2022).
[78] Logan J. Pallin et al., *A Surplus No More? Variation in Krill Availability Impacts Reproductive Rates of Antarctic Baleen Whales*, 29 Global Change Biology 2108 (2023).
[79] Clark et al., *supra* note 57, at 654.
[80] Claudia Tebaldi et al., *Extreme Sea Levels at Different Global Warming Levels*, 11 Nature Climate Change 746, 746 (2021).
[81] Rachel Warren et al., *Quantifying Risks Avoided by Limiting Global Warming to 1.5 or 2 °C Above Pre-Industrial Levels*, 172 Climatic Change 1, 10-11 (2022).
[82] Ronald Vernimmen & Aljosja Hooijer, *New LiDAR-Based Elevation Model Shows Greatest Increase in Global Coastal Exposure to Flooding to Be Caused by Early-Stage Sea-Level Rise*, 11 Earth's Future 1, 7 (2023).
[83] If the Court would like more information on the ecological and human impacts of 2.0°C of warming, we would be happy to provide it pursuant to the Court's request.

results are intended to provide a general idea of how these islands might be impacted by high tide flooding as sea levels rise.

In Antigua and Barbuda, MHHW will begin to reach schools starting at 2 m of sea-level rise: Old Road Primary School at 2 m; American University of Antigua at 3 m; Holy Trinity, Antigua and Barbuda Hospitality Training Institute, and Villa Primary School at 5 m. At 3 m of sea-level rise, MHHW reaches Hanna Thomas Hospital (the only hospital on Barbuda). Below are maps of other important areas that will be affected by rising MHHW, including airstrips.

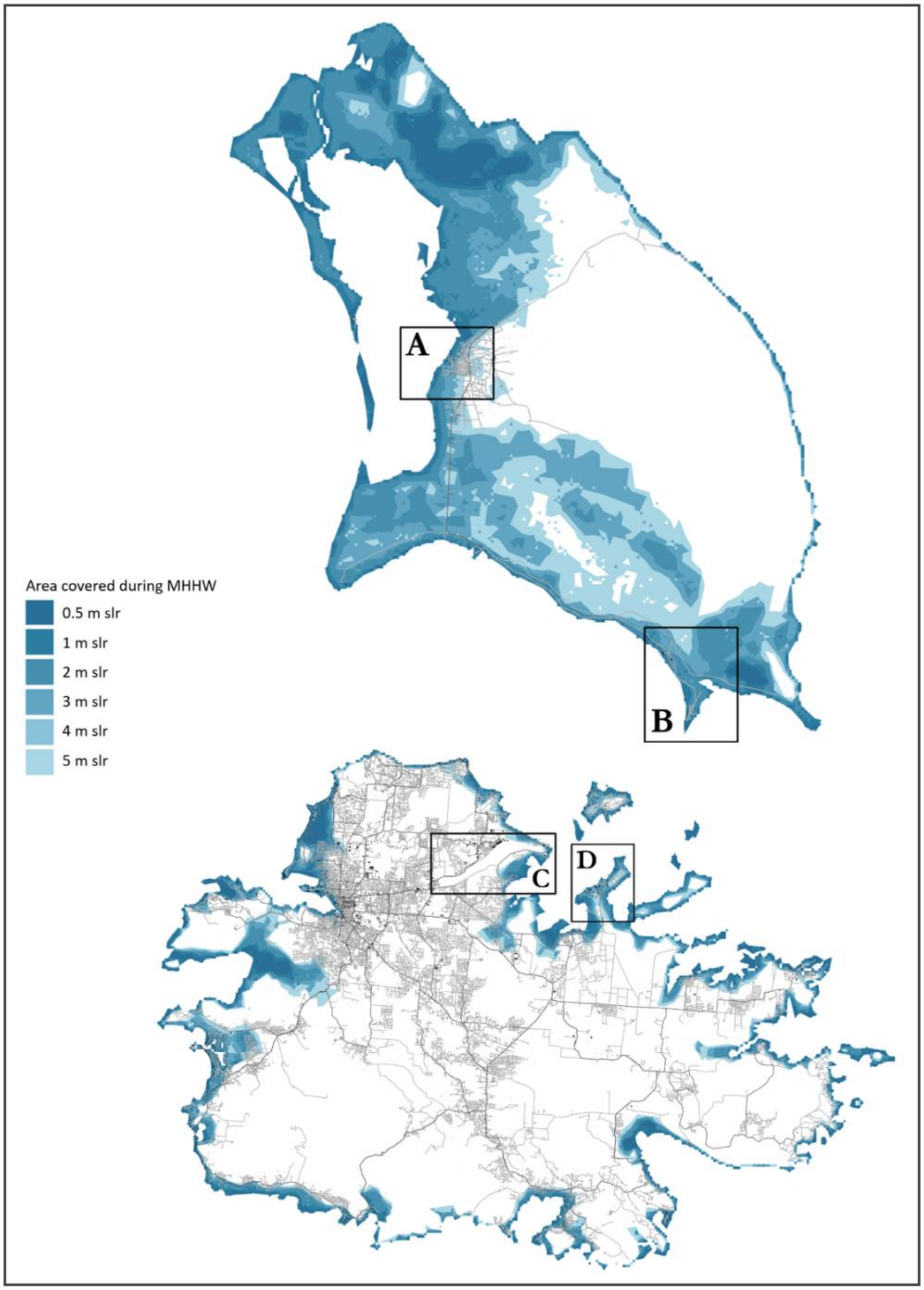


Figure 1. Map of Antigua & Barbuda showing coastlines covered during MHHW with 0.5 m, 1 m, 2 m, 3 m, 4 m, and 5 m of sea-level rise. Refer to maps 2.A through 2.D to see close-ups of important areas impacted by rising MHHW in Antigua & Barbuda.

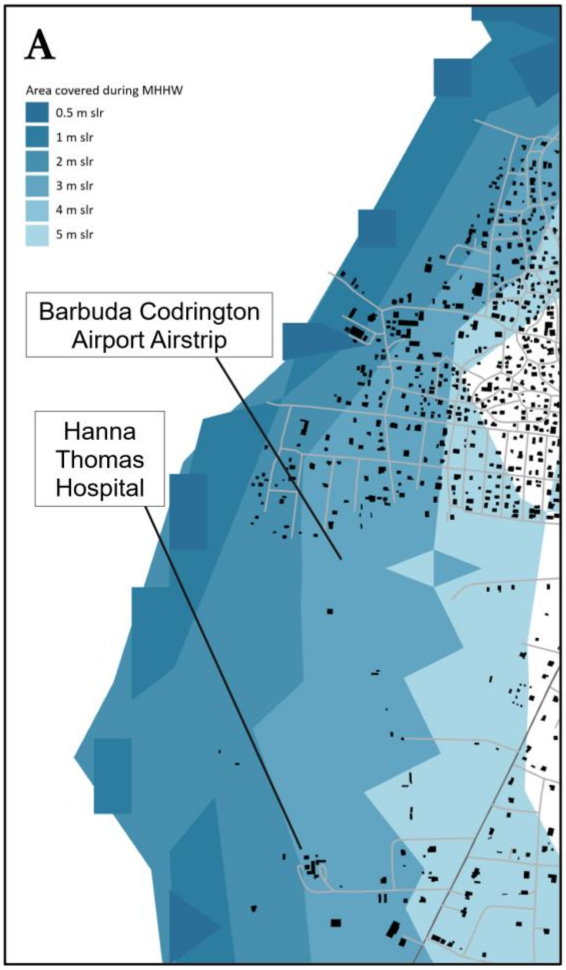


Figure 2.A (Barbuda) - With 2 m of sea-level rise, MHHW will impact the Barbuda Codrington Airport Airstrip and Hanna Thomas Hospital.

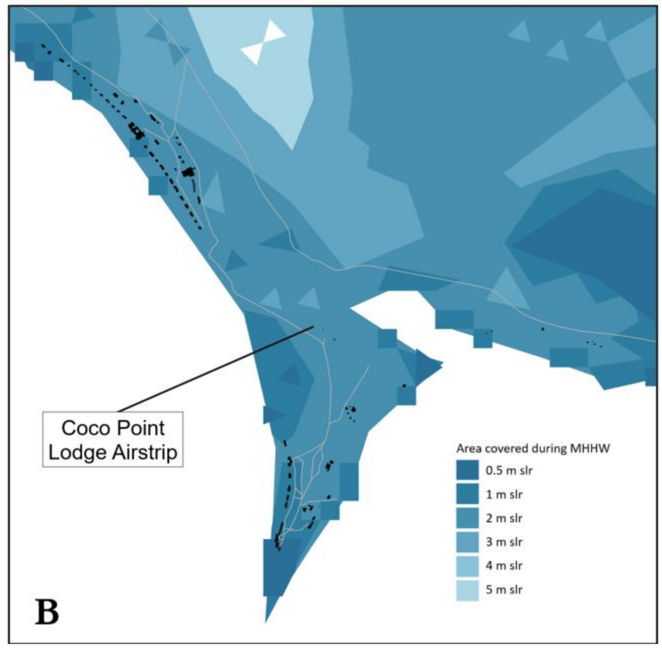


Figure 2.B (Barbuda) - With 2 m of sea-level rise, MHHW will impact the Coco Point Lodge Airstrip.

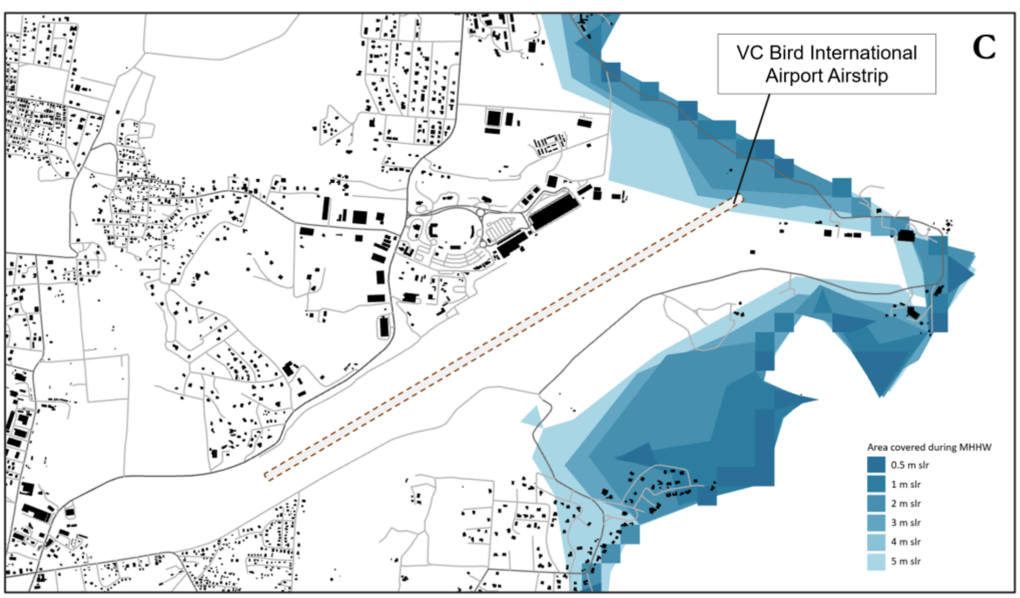


Figure 2.C (Antigua) - With 2 m of sea-level rise, MHHW will impact VC Bird International Airport.

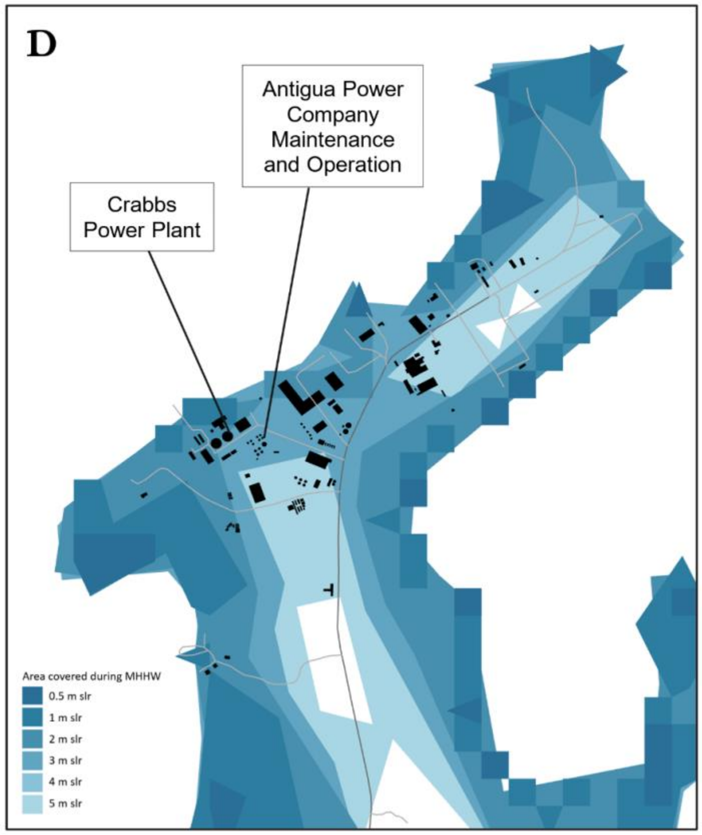
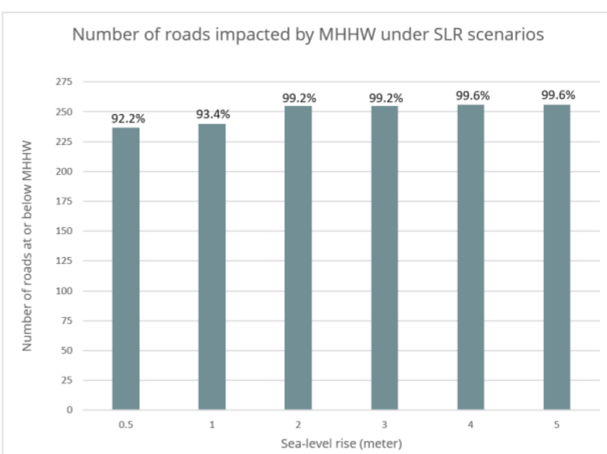


Figure 2.D (Antigua)- With 3 m of sea-level rise, MHHW will impact Crabbs Power Plant and Antigua Power Company Maintenance and

Even more starkly, at just 0.5 m of sea-level rise, MHHW reaches 92.2% of roads and 81% of buildings in Tuvalu including Seventh-Day Adventist Primary School, Princess Margaret Hospital, and Funafuti International Airport. As described above, the projected long-term rise in sea level will be 2.5-5 m at 1.5°C of warming above pre-industrial levels.



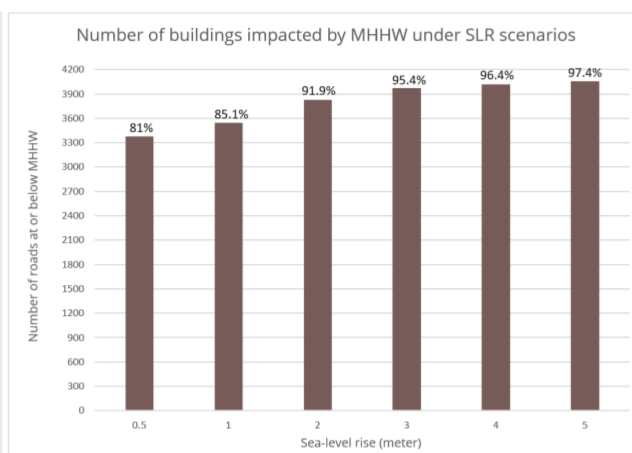


Figure 3. The number of roads and buildings in Tuvalu impacted by rising MHHW under 0.5 m, 1 m, 2 m, 3 m, 4 m, and 5 m of sea-level rise. The biggest jump in the number of impacted roads and buildings occurs between 1 m and 2 m sea-level rise.

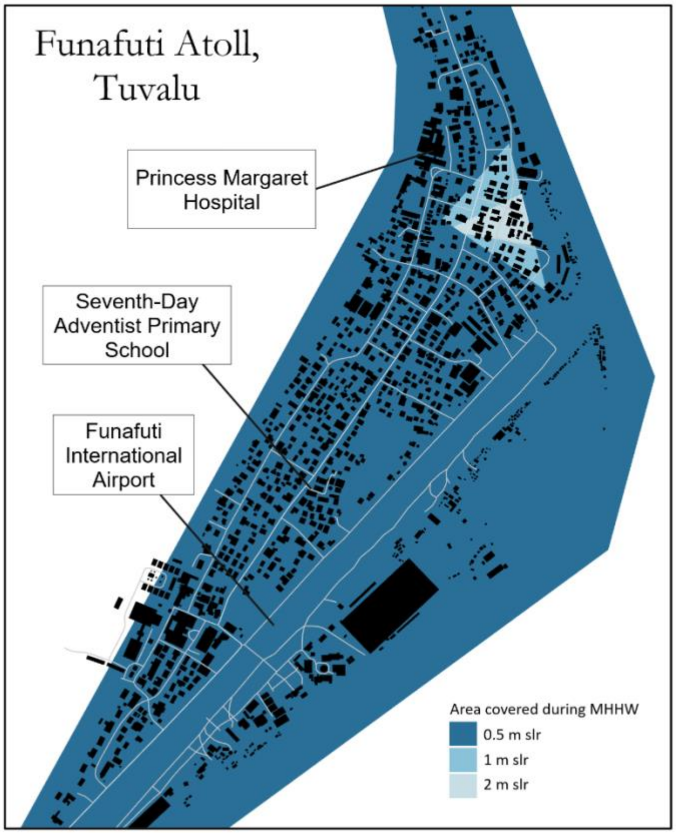


Figure 4. With only 0.5 m of sea-level rise in Tuvalu, Princess Margaret Hospital, Sevenths-Day Adventist Primary School, and Funafuti International Airport are some of the 81% of buildings that will be impacted by MHHW.

C. Allowing global average surface temperatures to remain elevated at current levels, let alone levels of 1.5°C (or more) above pre-industrial times, could trigger multiple climate tipping points

The best available science further finds that heating of up to 1.5°C or beyond for any length of time could drive our planet across several climate tipping points—also known as points of no return—that may make large areas of our planet uninhabitable for human beings. Climate tipping points are critical thresholds that, if crossed, would lead to large and likely irreversible changes in a component of the Earth's climate system that contributes significantly to the well-being of humanity.[84] Tipping points do not stand alone. If one tipping point is crossed, it increases the likelihood that others may be crossed as well, risking a "tipping cascade" of impact that could further reinforce global warming and result in runaway effects that cannot be controlled.[85] In other words, tipping points are like a row of dominoes. Once one is pushed over, it has the potential to drive Earth towards another, and it becomes very difficult or impossible to stop the whole row from tumbling down.

---

[84] McKay et al., *supra* note 18.
[85] Wunderling et al., *supra* note 18.

A September 2022 scientific study of climate tipping points determined that "[t]he Earth may have left a safe climate state beyond 1°C global warming."[86] Warming of 1.5°C-1.6°C only further increases the risk of runaway climate instability, "likely" leading to the triggering of four large-scale, irreversible, and destabilizing tipping points related to Earth's oceans: i) collapse of the Greenland ice sheet; ii) collapse of the West Antarctic ice sheet; iii) the die off of 70-90% of tropical and subtropical coral reefs; and iv) the abrupt loss of sea ice over the Barents Sea north of Scandinavia. The triggering of any one of these tipping points would have substantial impacts on the overall climate system—if more than one is triggered, the results can be expected to be catastrophic.

Earth may have already crossed a critical tipping point with the loss of summer ice over the Arctic Sea resulting in exposure of the blue sea to the summer sun, which leads to increased heat absorption by the ocean. As a result, the Arctic Circle has been heating up at a rate approximately four times faster than the average for the rest of the planet with an annual average temperature of ~3°C above pre-industrial temperatures for the region.[87] This heating is already causing the tipping point transition for this region to be reached,[88] and Greenland is losing so much ice that, without intervention, its complete melting will eventually raise the seas more than 7 m.[89] In addition, the Greenland ice sheet contains substantial amounts of permafrost that will release additional greenhouse gases, including CO_2 and methane, when it melts. According to renowned climate scientist, Sir David King, if all of the methane in the Arctic Circle permafrost (including the permafrost in Greenland) were emitted, the global average temperature would rise by 5°C-8°C over a 20-year period.[90] Global CO_2 pollution is the primary forcer of Arctic heating, melting, and resulting methane release, driving the Arctic toward that tipping point.

Even further, prolonged heating above 1.5°C would increase the rate and extent of Arctic Ocean acidification, threatening marine life in areas as far away as the Southern Ocean.[91] Similarly,

---

[86] *Id.* at 8.

[87] Mika Rantanen et al., *The Arctic Has Warmed Nearly Four Times Faster Than the Globe Since 1979,* 3 Comm. Earth Env't 168, 168 (2022), https://doi.org/10.1038/s43247-022-00498-3; Climate Crisis Advisory Group, *Extreme Weather Events in the Arctic and Beyond, A Global State of Emergency* 3 (2022), https://static1.squarespace.com/static/60ccae658553d102459d11ed/t/6102596bc768697d04731d55/1627543921216/CCAG+Extreme+Weather.pdf.

[88] Niklas Boers et al., *Critical Slowing Down Suggests That the Western Greenland Ice Sheet Is Close to a Tipping Point,* 118 Proc. Nat'l Acad. Sci.: Earth, Atmospheric, & Planetary Sciences 21 (2021), https://doi.org/10.1073/pnas.2024192118.

[89] Global vulnerability to sea-level rise and coastal flooding resulting from unprecedented ice sheet melt affects hundreds of millions of people worldwide with catastrophic results not just to densely populated coastal cities but also to vital hubs of the global agricultural economy—like Vietnam's low-lying rich rice production region, which will be under water much of the year with tens of millions of people displaced. Scott Kulp et al., *New Elevation Data Triple Estimates of Global Vulnerability to Sea-Level Rise and Coastal Flooding,* 10 Nature Comm. 4844 (2019), https://doi.org/10.1038/s41467-019-12808-z; Benjamin H. Strauss et al., *Unprecedented Threats to Cities from Multi-century Sea Level Rise,* 16 Env't. Res. Letters 1 (2021), https://iopscience.iop.org/article/10.1088/1748-9326/ac2e6b.

[90] Laurie Goering, *Analysis: As Climate 'Tipping Points' Near, Scientists Plan for the Unthinkable*, Reuters (Sept. 16, 2022), https://www.reuters.com/article/climate-change-science-disaster/analysis-as-climate-tipping-points-near-scientists-plan-for-the-unthinkable-idUSL8N30M40O (quoting Sir David King, the UK Government's Chief Scientific Advisor from 2000 to 2007 and the UK's permanent Special Representative for Climate Change from September 2013 until March 2017).

[91] Kloenne et al., *supra* note 69, at 11.

ocean acidification would reduce coral reef carbonate production by 76%[92] at 1.5°C. The Arctic Ocean will become ice free in most September months, and long-term committed sea-level rise will reach up to 10 m as the likelihood of Greenland and Antarctic ice-sheet destabilization increases.[93] Marine animal biomass will decrease by greater than 5%[94] while Belugas, Bowheads and Narwhals will lose approximately 25% of their summer Arctic habitat.[95] If GHG pollution continues to increase as it has in the first two decades of the 21st century, then 40-60% of marine species are at risk of extinction, wiping out the marine biodiversity that has evolved over the last 50 million years and rivalling the five great mass extinctions of the last 500 million years.[96]

D. In order to reverse runaway climate change, Earth's current energy imbalance must be stabilized by bringing atmospheric CO_2 concentrations back down to 350 ppm

The Paris temperature targets of 1.5°C to 2.0°C are an inadequate metric for measuring climate change and its impacts for three key reasons. First, such temperature targets are based on global averages despite the fact that surface temperatures are increasing at differing rates across the planet. As such, they fail to sufficiently account for geographical equity. Indeed, northern latitudes are already well over the lower Paris temperature target of limiting global average surface temperature rise to 1.5°C. The Arctic has warmed three to four times faster than the rest of the world since the 1970s, leading to annual average surface air temperatures more than 3°C above pre-industrial temperatures and an alarming peak temperature increase measurement over the north-eastern Barents Sea of ~10.6°C.[97] Such runaway warming has stark consequences for melting tundra and subsequent methane emissions, which further endanger populations in the Arctic Circle and around the world.[98] Second, scientific research suggests that the length of time Earth stays at elevated surface temperatures is fundamentally related to the severity of climate change hazards (i.e., longer periods of elevated temperature are associated with more severe impacts).[99] Yet, the Paris temperature targets neglect to address this issue at all. Third, average

---

[92] Christopher E. Cornwall et al., *Global Declines in Coral Reef Calcium Carbonate Production Under Ocean Acidification and Warming*, 118 Proceedings Nat'l Acad. Sci. 1, 1 (2021).
[93] Kloenne et al., *supra* note 69 at 10.
[94] Derek P. Tittensor et al., *Next-Generation Ensemble Projections Reveal Higher Climate Risks for Marine Ecosystems*, 11 Nature Climate Change 973, 977 (2021).
[95] Philippine Chambault et al., *Future Seasonal Changes in Habitat for Arctic Whales During Predicted Ocean Warming*, 8 Science Advances 1, 1 (2022).
[96] Justin L. Penn & Curtis Deutsch, *Avoiding Ocean Mass Extinction from Climate Warming*, 376 Science 524, 525 (2022).
[97] Arctic Monitoring and Assessment Program, *Arctic Climate Change Update 2021: Key Trends and Impacts, Summary for Policy-makers*, Arctic Council 5 (2021), https://www.amap.no/documents/download/6759/inline ("From 1971–2019, the annually averaged Arctic near-surface air temperature increased by 3.1°C, three times faster than the global average.") [hereinafter *Arctic Climate Change*]; Mika Rantanen, et al., *The Arctic Has Warmed Four Times Faster Than the Globe Since 1980*, 3 Comm. Earth & Env't 3 (2022), https://www.nature.com/articles/s43247-022-00498-3#citeas ("During 1970-2021, major portions of the Arctic Ocean were warming at least four times as fast as the global average[.]").
[98] *See Arctic Climate Change*, *supra* note 97.
[99] *See generally Young People's Burden*, *supra* note 14, at 595 (2017), https://esd.copernicus.org/articles/8/577/2017/) [hereinafter *Young People's Burden*] (noting that "[l]imiting the period and magnitude of temperature excursion above the Holocene range is crucial to avoid strong stimulation of slow feed-backs" that could trigger irreversible climate harms).

surface temperatures are difficult to measure with consistent precision, leading to volatile data with large variability.

Instead of looking at temperature targets, leading climate scientists widely agree that Earth's energy imbalance is the "*most critical*" metric for determining "*the prospects for continued global warming and climate change*"[100] because Earth's energy imbalance "is less subject to decadal variations associated with internal climate variability than global surface temperature and therefore represents a robust measure of the rate of climate change[.]"[101] Earth's energy imbalance is the imbalance in Earth's energy system resulting from the Earth releasing less energy back into space than it absorbs from the Sun.[102] Earth's energy imbalance can be thought of as an out-of-equilibrium energy balance sheet for our planet. For Earth's energy imbalance to equalize, all energy that comes into Earth's system must be counterbalanced by an equivalent amount of energy leaving Earth's system. Only then will Earth's energy balance sheet keep a net balance around zero, thereby maintaining the stable climate system that facilitated the evolution of the human species.

Fossil fuel combustion is the predominant driver of Earth's energy imbalance, and thereby climate change, because it leads to excessive greenhouse gas pollution, especially CO_2, which accumulates in Earth's atmosphere and traps more energy.[103] This excess energy accumulates to a substantial degree in Earth's oceans, which act as a natural sink for "spillover" heat energy. This excess heat is leading to dramatic consequences within aquatic environments around the world; for example, and as underscored above, sea ice in the Arctic Ocean is retreating at alarming rates, affecting heat circulation in the oceans and causing coastline threatening sea-level rise globally.

Even further, all of this excess heat is leading to floods, droughts, more powerful blizzards and hurricanes, and other deadly extreme events.[104] Scientists have concluded that reducing this heat-trapping effect by lowering greenhouse gas levels in the atmosphere is the only way to bring Earth's energy system back into equilibrium, thereby stabilizing the climate system and ultimately reversing climate change.[105] By analogy, Earth's energy imbalance can be thought of like cooking rice—if the right amount of heat is allowed to leave the pot, the rice cooks perfectly. If too much heat is trapped inside, the pot boils over. Right now, due to the excess heat, Earth is boiling over. Whereas temperature targets aim at suppressing a symptom of climate change (i.e., planetary heating), aiming to rebalance Earth's energy imbalance speaks directly to the cause of the problem (i.e., atmospheric greenhouse gas accumulation caused by humans).

In addition to identifying Earth's energy imbalance as such a crucial concept, scientists have pinpointed the level of atmospheric carbon dioxide that will allow Earth's energy imbalance to stabilize, thus putting a stop to ever worsening climate change. Specifically, climate scientists

---

[100] von Schuckmann et al., *supra* note 9, at 2014 (emphasis added).
[101] *Id.* at 2015.
[102] *Id.* at 2014-15.
[103] *See* University Corporation for Atmospheric Research: Centre for Science Education, *Why Does Climate Change?* (2022), https://scied.ucar.edu/learning-zone/how-climate-works/why-does-climate-change; *see generally* United Nations, *Causes and Effects of Climate Change*, Climate Action, https://www.un.org/en/climatechange/science/causes-effects-climate-change#:~:text=Fossil%20fuels%20%E2%80%93%20coal%2C%20oil%20and,they%20trap%20the%20sun's%20heat.
[104] Liz Fuller-Wright, *'Less Than 1% Probability' That Earth's Energy Imbalance Increase Naturally, Say Scientists*, Phys.org (Jul 28, 2021), https://phys.org/news/2021-07-probability-earth-energy-imbalance-naturally.html.
[105] von Schuckmann et al., *supra* note 9, at 2029.

conclude that **atmospheric CO_2 must be reduced from 2022 levels of 419 ppm to less than 350 ppm as rapidly as possible to stop catastrophic climate change[106] and its irreversible harms to our oceans and marine environments.** This finding highlights the gravity of Planet Earth's situation. A seminal paper published in 2008 by top climate researchers—including Dr. James Hansen, former Director of the NASA Goddard Institute for Space Studies[107] and Yale Professor Robert Berner[108]— concluded that the Earth is "already in the danger zone" at then-current levels of 385 ppm atmospheric CO_2. This finding also highlights the fundamental inadequacy of the Paris temperature targets. In 2018, Dr. Hansen testified that "the political guardrail of 2°C of warming," which roughly equates to approximately 450 ppm atmospheric CO_2, is "extremely dangerous[.]"[109] Dr. Hansen went on to indicate that "[s]uch warming would lock in eventual loss of coastal cities, including more than half of the world's large cities."[110]

E. Pathways to achieve the 350 ppm atmospheric CO_2 standard exist and are technologically feasible.

The longer Earth's energy remains out of balance, the higher the risk that irreversible feedback loops (e.g., ice-sheet melting and attendant sea-level rise, permafrost melting and attendant methane release, etc.) will be triggered.[111] To avoid these feedback loops and to prevent further global-warming induced climate destabilization, leading climate scientists conclude—as detailed above—that Earth's energy balance must be restored by rapidly reducing atmospheric CO_2 concentrations.[112] To do so, the U.S. National Academy of Sciences indicates that States must prioritize two fundamental actions: i) dramatically decreasing economy-wide CO_2 and other

---

[106] *Young People's Burden*, *supra* note 14, at 578.

[107] Dr. James Hansen worked at NASA for 46 years and served as the Director of NASA's Goddard Institute for Space Studies (GISS) for 32 years. (NASA is one of two primary U.S. federal expert agencies tasked with studying the climate system and climate change today.) Currently, he serves as Director of the Program on Climate Science, Awareness and Solutions at Columbia University's Earth Institute. *See Dr. James Hansen*, Columbia Climate School: Climate, Earth, and Society (2022), https://people.climate.columbia.edu/users/profile/james-e-hansen#:~:text=James%20Hansen%2C%20formerly%20Director%20of,space%20science%20program%20of%20Dr.; *see also*, Mark Memmott, *James Hansen, NASA Scientist Who Raised Climate Change Alarm, Is Retiring*, NPR (Apr. 2, 2013), https://www.npr.org/sections/thetwo-way/2013/04/02/176010296/james-hansen-nasa-scientist-who-raised-climate-change-alarm-is-retiring; David Biello, *Why Jim Hansen Stopped Being a Government Scientist [Video]*, Sci. Am. (Apr. 12, 2013), https://blogs.scientificamerican.com/observations/why-jim-hansen-stopped-being-a-government-scientist-video/.

[108] *Target Atmospheric CO_2*, *supra* note 12, at 225; Robert Berner "developed the first whole-Earth mathematical model of CO_2 exchange, which revealed marked changes in our planet's past atmospheric levels and the rates at which natural processes might remove anthropogenic CO_2 from the atmosphere." Don Canfield, *Robert A. Berner (1935-2015)*, 518 Nature 484, 484 (2015), https://www.nature.com/articles/518484a.

[109] Hansen Expert Report, *supra* note 12, at 23

[110] *Id.*

[111] James Hansen et al., *Assessing "Dangerous Climate Change": Required Reduction of Carbon Emissions to Protect Young People, Future Generations and Nature*, 8 PLOS ONE 1, 6 (2013) [hereinafter *Assessing "Dangerous Climate Change"*]; *Young People's Burden*, *supra* note 14, at 578.

[112] Johan Rockström et al., *Safe and Just Earth System Boundaries*, Nature 1, 8 (2023), https://www.nature.com/articles/s41586-023-06083-8; von Schuckmann et al., *supra* note 9, at 2029.

greenhouse gas emissions; and ii) maximizing the removal of already existing carbon pollution from the atmosphere.[113]

This submission focuses on the first action which will require transitioning quickly from relying on CO_2-emitting fossil fuel combustion for energy production in all sectors to cleaner, renewable energy. Action is also required to dramatically reduce greenhouse gas pollution to the lowest levels possible from other non-fossil fuel-based sources such as deforestation and agricultural production.[114]

The primary reason for mentioning the second action – which is an equally crucial component – only cursorily is because it can be and has been erroneously used as a justification for limiting efforts to reduce greenhouse gas pollution. Although atmospheric CO_2 draw down is a crucial aspect of efforts to restore balance to Earth's energy system, it must be conducted *additionally* to greenhouse gas emission reduction efforts, not in replacement of such efforts. Furthermore, the amount of atmospheric draw-down that could reasonably be achieved through carbon removal is necessarily limited in order to avoid drawing on land required to meet world food supply requirements and to support the livelihoods of marginalised groups.[115]

While this transition may appear challenging on first blush, numerous scientific studies indicate that rapid reductions in CO_2 pollution are feasible because CO_2-emitting fossil fuels are not needed to power human energy systems.[116] While the switch cannot flip over night, it is both technically and economically feasible for State Parties to transition from a predominantly fossil fuel-based energy system to one that eliminates those fuels and their pollution on a pathway that would be consistent with what science indicates is necessary to restore Earth's energy balance and at the same time positively drive forward economies around the world in both the short- and long-term.[117] The bottom line is that in order to restore balance in line with the 350 ppm limit, fossil fuels must be replaced by 2050 globally and Earth's natural carbon sinks such as forests and oceans need to be restored and protected to maximize their carbon sequestration potential.[118]

Leading energy scientists have developed roadmaps providing States with pathways to rapidly transition energy infrastructure in all sectors to 100% clean, renewable energy by as early

---

[113] Nat'l Acad. of Sci., Eng'g, and Med., *Climate Change: Based on Science* (Oct. 27, 2021), https://www.nationalacademies.org/based-on-science/is-it-possible-to-achieve-net-zero-emissions#:~:text=Achieving%20zero%20emissions%20means%20releasing,oxide%20or%20other%20greenhouse%20gases.

[114] Steven Davis et al., *Net-Zero Emissions Energy Systems*, 360 Sci. 1, 1 (2018).

[115] *See* Oxfam International, *Tightening the Net: Net Zero Climate Targets – Implications for Land and Food Equity*, Oxfam (2021) https://oxfamilibrary.openrepository.com/bitstream/handle/10546/621205/bp-net-zero-land-food-equity-030821-en.pdf;jsessionid=D9F0B38B5B37AD28FF6DDA16C36F2149?sequence=1.

[116] *See, e.g.*, Price-Waterhouse-Coopers LLP et al., *100% Renewable Electricity: A Roadmap to 2050 for Europe and North Africa* (2010), https://www.pwc.co.uk/assets/pdf/100-percent-renewable-electricity.pdf; *Low-cost Solutions for 145 Countries*.

[117] *See generally* John Berger, *Mark Jacobson: How One American Atmospheric and Climate Scientist Created Clean Energy Roadmaps for 50 U.S. States—and 139 Nations,* Sustain Europe: U.S.A. Focus (2019), https://web.stanford.edu/group/efmh/jacobson/Articles/I/19-04-SustainEurope.pdf.

[118] *See generally* Mark Jacobson, *100% Clean, Renewable Energy and Storage for Everything* (Cambridge Univ. Press ed., 2020), http://web.stanford.edu/group/efmh/jacobson/Articles/I/CountryGraphs/CO2ChangesWithWWS.pdf; Christian Breyer et al., *On the History and Future of 100% Renewable Energy Systems Research*, 10 IEEE Access, 78176, 78195 (2022), https://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=9837910.

as 2035, but by no later than 2050, with an 80% transition by 2030.[119] States' transition to wind, water, and solar energy and their elimination of 80% of all emissions by 2030 and 100% by 2035–2050 is essential to allow the Earth's climate to begin stabilizing and cooling to lower average temperatures, thus avoiding the dangers of locking in 1.5°C of heating for a prolonged length of time.[120] Such a transition is possible, reasonable, and absolutely necessary to uphold numerous State obligations under the Convention. Hundreds of studies support the feasibility of such transition pathways,[121] and "[t]he main conclusion of most of these studies is that [achieving] 100% renewables is feasible worldwide at low cost. Advanced concepts and methods now enable the field to chart realistic as well as cost- or resource-optimized and efficient transition pathways to a future without the use of fossil fuels."[122]

The roadmaps generally involve electrifying all energy sectors (electricity, transportation, heating/cooling buildings, industry) with existing or in-development technologies and generating the electricity to power all appliances, vehicles, and machines people use with 100% wind, water, and sunlight (i.e., renewable energy).[123] The necessary electricity can be generated by onshore and offshore wind, utility-scale photovoltaics, rooftop photovoltaics, geothermal power, tidal and wave power, and hydroelectric power[124] and can be supplied through a storage network of electricity, heat, cold, and green hydrogen along with an expanded transmission and distribution system.[125] Importantly, in an electrified energy system, there is enormous reduction in end-use power demand due to: i) the efficiency of predominantly electric vehicles as compared to internal combustion engines; ii) the efficiency of heat pumps for air and water as well as industrial heating processes as compared to combustion heaters; iii) the elimination of fossil fuel mining, refining, transport, infrastructure; and iv) additional end-use appliance and machine efficiency improvements that will likely continue to evolve after eliminating fossil fuel combustion. [126]

States have recognized the viability of these transition pathways and have begun to adopt them into their laws and policies. For example, Denmark has already committed to achieve 100% renewable energy in all sectors by 2050.[127] Air transportation will likely be one of the last frontiers of the renewable energy transition during the 2040s; indeed, Norway has already committed to a

---

[119] *Low-cost Solutions for 145 Countries*, *supra* note 20, at 3347; *see also* Mark Jacobson, *More Hopeful Calculations for the Energy Transition*, Nat'l Acad. Eng'g: Issues Sci. & Tech. (Feb. 18, 2022), https://issues.org/renewables-minerals-energy-transition-jacobson-forum/.

[120] *Low-cost Solutions for 145 Countries*, *supra* note 20, at 3343.

[121] *See, e.g.,* Breyer et al., at 78187 (noting the field of 100% renewable energy systems research "has quickly grown with hundreds of published papers by many different research groups across the world[.]").

[122] *Id.* at 78176.

[123] *Low-cost Solutions for 145 Countries*, *supra* note 20; Mark Jacobson et al., *Zero Air Pollution and Zero Carbon from All Energy at Low Cost and Without Blackouts in Variable Weather Throughout the U.S. with 100% Wind-Water-Solar and Storage*, 184 Renewable Energy*,* 430 (2022) https://web.stanford.edu/group/efmh/jacobson/Articles/I/21-USStates-PDFs/21-USStatesPaper.pdf [hereinafter *Zero Air Pollution*].

[124] *Low-cost Solutions for 145 Countries*, *supra* note 20, at 3344-45; *Zero Air Pollution*, *supra* note 123, at 430.

[125] *Id.*

[126] *Id.* at 434.

[127] William Brittlebank, *Denmark Targets 100% Renewable Electricity by 2050*, Climate Action (Jul. 28, 2016), https://www.climateaction.org/news/denmark_targets_100_renewable_electricity_by_2050#:~:text=William%20Brittlebank-,Currently%2C%2040%20per%20cent%20of%20Denmark's%20electricity%20comes%20from%20wind,per%20cent%20renewables%20by%202050.

fleet of electric aircraft for short-haul flights by 2040[128] and many companies are currently developing electric and hydrogen fuel cell aircraft.[129]

Historically States have chosen, out of political preference, to develop widespread fossil fuel infrastructure and dependency. This was, and is now, unequivocally a choice. Today, States have the opportunity—a clear roadmap—to transition to renewables.

The Tribunal can learn more about natural removal solutions via coastal mangroves, salt marshes and sea grass, terrestrial wetlands, grasslands and forests, agricultural lands, and rangelands from scientific experts across the world who have been researching the potential to remove vast amounts of legacy CO_2.[130] The Centre for Climate Repair, for example, is engaged in innovative research and early small scale efforts to achieve marine biomass regeneration by restoring whales' vital function in ocean ecosystems and by making efforts to restore giant kelp beds.[131] Additionally, if the Court would like a synopsis of this area of the science, the authors of this submission would gladly provide more detailed information upon request.

IV. The Misalignment of the Paris Temperature Targets and the 350 ppm limit

The difference between the Paris temperature targets of 1.5°C to 2.0° and the 350 ppm limit reflects the abyss between consensus political decision making and scientific evidence. The Paris temperature targets were reached through negotiations and by political consensus rather than through scientific analysis. While a thorough history of how 1.5°C–2.0°C became the politically

---

[128] Stephen Dowling, *Norway's Plan for a Fleet of Electric Planes*, BBC Future (Aug. 22, 2018), http://www.bbc.com/future/story/20180814-norways-plan-for-a-fleet-of-electric-planes.

[129] Jessica Reed, *10 Airlines That Made Electric and Hydrogen-powered Aircraft Investments, Partnerships in 2021*, Avionics Int'l (Jan. 1, 2022), https://www.aviationtoday.com/2022/01/01/10-airlines-made-electric-hydrogen-powered-aircraft-investments-partnerships-2021/.

[130] *See, e.g.*, Keith Paustian, *Climate-smart Soils*. 532 Nature 49 (2016); Bronson Griscom et al., *Natural Climate Solutions,* 114 Proc. Nat'l Acad. Sci.: Earth, Atmospheric, and Planetary Sciences 11645 (2017), https://doi.org/10.1073/pnas.1710465114; Joseph Fargione et al., *Natural Climate Solutions for the United States*, 4 Sci. Advances 1 (2018); Beverly Law et al., *Land Use Strategies to Mitigate Climate Change in Carbon Dense Temperate Forests*, 115 Proc. Nat'l Acad. Sci. 3663 (2018); Pete Smith et al., *How to Measure, Report and Verify Soil Carbon Change to Realize the Potential of Soil Carbon Sequestration for Atmospheric Greenhouse Gas Removal*, 26 Glob. Change Biology 219 (Aug. 2019), https://doi.org/10.1111/gcb.14815; Mark A. Bradford et. al, *Soil Carbon Science for Policy and Practice*, 2 Nature Sustainability 1 (2019); J. Boone Kauffman et al., *Total Ecosystem Carbon Stocks at the Marine-Terrestrial Interface: Blue Carbon of the Pacific Northwest Coast, United States*, 26 Glob. Change Biology 5679 (2020), https://onlinelibrary.wiley.com/doi/full/10.1111/gcb.15248; G. Philip Robertson et al., *Land-based Climate Solutions for the United States*, 28 Glob. Change Biology 4912 (2022), https://doi.org/10.1111/gcb.16267; Christine Bertram et al. *The Blue Carbon Wealth of Nations*, 11 Nature Climate Change 704 (2021).

[131] Centre for Climate Repair, *Remove Greenhouse Gas*, https://www.climaterepair.cam.ac.uk/remove; *see generally* Christine Bertram et al., *The Blue Carbon Wealth of Nations,* 11 Nature Climate Change, 704 (2021) at https://www.nature.com/articles/s41558-021-01089-4; Anaëlle Durfort et al., *Recovery of Carbon Benefits by Overharvested Baleen Whale Populations Is Threatened by Climate Change,* 289 Proceed. of the Royal Soc. B 1 (2022), https://doi.org/10.1098/rspb.2022.0375; Wilson Thau Lym Yong et al., *Seaweed: A Potential Climate Change Solution,* 159 Renewable & Sustainable Energy Rev. 1 (2022), https://doi.org/10.1016/j.rser.2022.112222; Mohd Safwan Azman et al., *Stand Structure, Biomass and Dynamics of Naturally Regenerated and Restored Mangroves in Malaysia,* 482 Forest Ecology & Mgmt. 1 (2021), https://doi.org/10.1016/j.foreco.2020.118852; Ove Hoegh-Guldberg et al. *The Ocean as a Solution to Climate Change: Five Opportunities for Action*, World Res. Inst. (2019); https://oceanpanel.org/publication/the-ocean-as-a-solution-to-climate-change-five-opportunities-for-action/.

accepted target for policy makers and States is beyond the scope of this submission, it is available to the Court.[132] Instead, this section provides a very brief overview of the context that resulted in the international acceptance of Paris temperature targets even though the scientific community had already alerted the Paris Agreement delegates that the targets would fail to halt and reverse run away climate change and had already identified 350 ppm as the limit humanity should aim for.

The United Nations Framework Convention on Climate Change ("UNFCCC") is an international treaty that came into force in 1994 with the goal to achieve "stabilization of greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system."[133] However, UNFCCC negotiators purposefully did not define "dangerous," nor did they promote a specific numeric target for greenhouse gas concentration stabilisation. Over the next twenty years, policy makers participated in contentious discussions striving to reach an international agreement on what an achievable target should be and how best to reach it.

During that time, the ability of climate scientists "to understand the mechanisms driving global warming and predict the impacts more precisely [] improved dramatically."[134,135] As discussed above, analysis of Earth's energy imbalance led many leading scientists to determine as early as 2008 that 2°C global warming (equivalent to an atmospheric CO_2 concentration of around 450 ppm) would be "extremely dangerous."[136] Rather, their "scientific understanding indicated an initial target of no more than 350 ppm CO_2 to avoid dangerous impacts[.]"[137] Nevertheless, institutions around the world became set on the idea of 2.0°C as the long-term, political target, "even though there was substantial scientific evidence showing such a target was highly dangerous to humanity."[138]

In 2015, at the 21st Conference of the Parties,[139] negotiators collectively agreed to the Paris Agreement, committing to a 2°C target with an aspiration toward limiting global warming to 1.5°C.[140] Today, voluminous and mounting scientific evidence concludes that this categorically insufficient and dangerous political target should not be relied upon as a *de facto* legal standard to

---

132 Rodgers et al, *supra* note 8; *see also* Piero Morseletto et al., *Governing by Targets: Reductio Ad Unum and Evolution of the Two-Degree Climate Target*, 17 Int'l Env't Agreements: Pol., L. & Econ. 660 (2017).

133 United Nations Framework Convention on Climate Change, May 9, 1992, 1771 U.N.T.S. 107, Art. 2, https://perma.cc/4VRY-MTKP.

134 Hansen Expert Report, *supra* note 12, at 17.

135 Since scientists rely on climate models to project how changes will play out over decades, they continually sought ways to better corroborate their findings. Importantly, in the early 1990s, NASA launched its Earth Observing System (EOS). EOS is comprised of a series of coordinated polar-orbiting satellites designed to monitor and understand key components of the climate system and their interactions with long-term global observations. This marked a key turning point for climate science as these satellites gave scientists—and our political leaders—new eyes on the atmosphere allowing scientists to fact check the extensive climate modelling they had methodically been developing for over a century based on greenhouse gas measurements being taken at monitoring stations around the globe. *See* NASA's Earth Observing System, *Missions: Earth Observing System (EOS)*, NASA (Dec. 4, 2022), https://eospso.nasa.gov/mission-category/3.

136 Hansen Expert Report, *supra* note 12, at 23.

137 *Id.* at 22.

138 *Id.* at 23.

139 The Conference of the Parties is the negotiating decision-making body of the UNFCCC that meets annually and is charged with evaluating and promoting the implementation of the UNFCCC. *See* United Nations Climate Change, *Supreme Bodies: Conference of the Parties (COP)* (2022), https://unfccc.int/process/bodies/supreme-bodies/conference-of-the-parties-cop.

140 Paris Agreement, *supra* note 4, at Art. 2.

protect our ecology and human systems, and instead courts should use the most up-to-day and best available science when determining how to remedy catastrophic harms caused by States.

V. Applicability of the Best Available Scientific Evidence to Interpretation of the Convention

The best available climate science presented in this submission is a paramount consideration for the Tribunal as it deliberates on these advisory opinion proceedings relating to State Party obligations in the context of climate change. The Convention itself recognizes the importance of scientifically informed enforcement mechanisms when it requires States to work together to "establish[] appropriate scientific criteria for the formulation and elaboration of rules, standards and recommended practices and procedures for the prevention, reduction and control of pollution of the marine environment."[141] Similarly, both explicit provisions and implicitly incorporated international legal principles of the Convention are crucially informed by up-to-date, rigorous scientific data. In order to correctly interpret the responsibilities of State Parties under the Convention in the context of climate change, the Tribunal must therefore turn to the best available climate science as a guide.

A. Careful consideration of the best available scientific evidence is crucial in order to adequately interpret explicit provisions of the Convention in the context of climate change

Several key provisions under the Convention are relevant to the advisory opinion proceedings currently before the Tribunal. Most fundamentally, Article 192 of the Convention indicates that "States have the obligation to protect and preserve the marine environment."[142] Based on the scientific evidence presented in Section III of this submission, it is clear that States' greenhouse gas emitting behavior is leading to climate change that subsequently alters oceans and marine ecosystems in deleterious ways. As such, State behavior that allows further greenhouse gas pollution and that fails to account for the need to pull excess CO_2 out of the atmosphere in order to stabilize Earth's energy system is not in compliance with the legal principle imposed on State Parties under Article 192 of the Convention. Notably,

> The thrust of article 192 is not limited to the prevention of prospective damage to the marine environment but extends to the 'preservation of the marine environment.' Preservation would seem to require active measures to maintain or improve, the present condition of the marine environment[.][143]

Under this interpretation, Article 192 imposes both negative and positive obligations on State Parties not only to avoid actively causing harm to the marine environment but also to proactively take steps to preserve and protect oceanic ecosystems.

Similarly, Article 194 of the Convention calls on State Parties to "take, individually or jointly as appropriate, all measures consistent with this Convention that are necessary to prevent, reduce and control pollution of the marine environment from any source, using for this purpose

[141] Convention, *supra* note 1, at Art. 201.
[142] Convention, *supra* note 1, at Art. 192.
[143] Myron Nordquist et al., UNCLOS 1982 Commentary Volume IV (2012) at 40.

the best practicable means at their disposal and in accordance with their capabilities[.] . . ."[144] The article goes further to specify that,

> States shall take *all measures necessary* to ensure that activities under their jurisdiction or control *are so conducted as not to cause damage by pollution to other States and their environment*, and that pollution arising from incidents or activities under their jurisdiction or control does not spread beyond the areas where they exercise sovereign rights in accordance with this Convention.[145] (emphasis added).

These provisions are fundamentally in keeping with Principle 7 of the Declaration of the United Nations Conference on the Human Environment which similarly mandates that "States shall take all possible steps to prevent pollution of the seas by substances that are liable to create hazards to human health, to harm living resources and marine life, to damage amenities or to interfere with other legitimate uses of the sea."[146] Even further one of twenty-three principles "endorsed by the Stockholm Conference" reiterates, "Every State has a duty to protect and preserve the marine environment and, in particular, to prevent pollution that may affect areas where an internationally shared resource is located."[147] Theis principle was adopted at a 1971 session of the Intergovernmental Working Group on Marine Pollution and has since been suggested as a "guiding concept[] for the Conference on the Law of the Sea."[148]

The Convention further notes that the measures called for in Article 194 must apply to "all sources of pollution of the marine environment."[149] Noting that these provisions reference "any" and "all" sources of marine pollution, it is clear that the legal principle established under Art. 194 applies to State Parties' greenhouse gas pollution that contaminates the marine environment both by altering ocean chemistry directly through ocean acidification[150] and by changing atmospheric chemistry such that the marine environment is affected indirectly through the multitudinous outcomes of climate change as described in detail in Section III of this submission.[151] This conclusion is further supported by the fact that direct and indirect climate change impacts threaten "rare or fragile ecosystems as well as the habitat of depleted, threatened or endangered species and other forms of marine life[,]"all of which are specifically called out for protection and preservation in the Convention.[152] As discussed in Section III, many of the marine ecosystems and ocean flora most threatened by climate change such as coral reefs, Southern Ocean humpback whale communities, scallops in the Eastern United States, and diverse animal populations in the Arctic

---

[144] Convention, *supra* note 1, at Art. 194(1).
[145] Convention, *supra* note 1, at Art. 194(2) (emphasis added).
[146] Declaration of the United Nations Conference on the Human Environment, Stockholm Declaration, Princ. 7 (Jun. 16, 1972), http://www.un-documents.net/unchedec.htm. [hereinafter Stockholm Declaration].
[147] Text of a Statement by Mr. J.A. Beesley, Representative of Canada to the United Nations Seabed Committee Sub-Committee III, Geneva Palace of Nations (July 20, 1972), https://www.library.ubc.ca/archives/pdfs/beesley/Beesley_2_8_5.pdf.
[148] Nordquist et al., *supra* note 143, at 37.
[149] Convention, *supra* note 1, at Art. 194(3).
[150] *See, e.g.,* Steve Doo, et al., *Ocean Acidification Effects on In Situ Coral Reef Metabolism*, 9 Sci. Rep. 1 (2019) https://www.nature.com/articles/s41598-019-48407-7.
[151] *See e.g.,* Peter Haugan, *Impacts on the Marine Environment from Direct and Indirect Ocean Storage of* CO_2*,* 17 Waste Management 323 (1998) https://www.sciencedirect.com/science/article/abs/pii/S0956053X97100435.
[152] Convention, *supra* note 1, at Art. 194(5).

Ocean and Mediterranean Sea are "rare and fragile" and contain or represent depleted, threatened, and endangered species.

The Convention notes that the measures to prevent, control, and reduce pollution of the marine environment should involve the adoption of laws and regulations, particularly with regard to pollution from land-based sources (Art. 207), sea-bed activities within a State's jurisdiction (Art. 208), sea-bed activities in the Area outside a particular State's jurisdiction (Art. 209), and the atmosphere (Art. 212). These particular sources of pollution are all implicated for numerous State Parties in the context of climate change. Regarding Art. 207, land-based sources of greenhouse gas pollution affecting marine environments include the multitudinous fossil-fuel burning activities that all State Parties authorize and regulate within their respective national jurisdictions. That pollution affects the oceans by way of the atmosphere, implicating Art. 212. Some, but not all, State Parties also conduct fossil fuel drilling activities either within their seabed jurisdiction or outside of it, thereby implicating Art. 208 and Art. 209 respectively. The Convention further commands states to *enforce* the laws and regulations with regard to these sources of pollution to the marine environment.[153] In the context of these advisory opinion proceedings, State Parties unequivocally have obligations under the Convention not only to put into place laws and regulations regarding the mitigation of climate change but also to enforce those laws and regulations for the purpose of preserving and protecting the marine environment.

B. Careful consideration of the best available scientific evidence is crucial in order to adequately interpret principles of international environmental law that are pertinent to the Convention

International environmental legal principles are particularly relevant to the advisory opinion proceedings, and those principles carry significant weight in the face of the best available science. The Convention broadly acknowledges the interconnection of its own provisions with other areas of international law when it states, "The sovereignty over the territorial seas is exercised subject to this Convention and to other rules of international law."[154] Article 235 of the Convention more specifically notes that "States are responsible for the fulfilment of their international obligations concerning the protection and preservation of the marine environment."[155] Principles of international environmental law, such as the requirement to prevent transboundary environmental damage and the polluter pays principle, incorporate requirements for the protection of the marine environment. As such, these principles are indirectly highlighted and asserted under Article 235. Even further, Article 237 makes it clear that the provisions of the Convention as they relate to the protection and preservation of the marine environment should be interpreted in the context of evolving international environmental law as it relates to the oceans.[156] As such, interpreting the provisions of the Convention in terms of the obligations it imposes on State Parties necessitates an examination of the international environmental legal principles that inform and

---

[153] *Id.* at Arts. 213, 214, 215, 222.

[154] *Id.* at Arts. 2; *see also*, *id.* at Arts. 19, 21 (defining and specifying regulations around innocent passage through a States' territorial waters "in conformity with this Convention and with other rules of international law").

[155] *Id.* at Art. 235(1).

[156] *Id.* at Art. 237(1) ("The provisions of this Part are without prejudice to the specific obligations assumed by States under special conventi3ons and agreements concluded previously which relate to the protection and preservation of the marine environment and to agreements which may be concluded in furtherance of the general principles set forth in this Convention.")

complement those obligations. This is particularly true in the context of this advisory opinion proceeding as the Tribunal interprets the requirements of States under the Convention "to protect and preserve the marine environment"[157] and to take all measures "necessary to prevent, reduce, and control pollution of the marine environment from any sources,"[158] including "[p]ollution from or through the atmosphere"[159] in the context of climate change.

The principle to prevent transboundary harm to other States and to the shared environment is a long-standing principle of international environmental law, articulated under numerous legal authorities,[160] including the Convention.[161] This principle establishes that States are required to "take all appropriate measures to prevent significant transboundary harm or at any event to minimize the risk thereof" for activities conducted in their jurisdiction.[162] In the context of climate change, Section III of this submission articulates substantial scientific evidence demonstrating the gravity and severity of transboundary harm to the oceans due to the emission of greenhouse gas pollution as authorized and endorsed by State Parties. As such this "no harm" principle—in conjunction with the explicit requirement under the Convention for States to take measures to prevent atmospheric pollution to marine environments—should inform the Tribunal's deliberations in the current advisory opinion proceeding.

Other principles of international environmental law relevant to these proceedings include the principle of common but differentiated responsibilities and the polluter pays principle (the latter being incorporated in the Convention at Article 235(3)).[163] These principles speak to the concerns of equity embedded in the climate crisis, which is and has been primarily fueled by developed nations while the adverse consequences are now being endured disproportionately by developing nations. Increasingly accurate attribution science demonstrates that the USA, the European Union, Russia, Japan, and Canada were responsible for 85% of excess global emissions above and beyond their "fair share" as of 2015,[164] whereas the top three nations most impacted by

---

[157] *Id.* at Art. 192.
[158] *Id.* at Art. 194.
[159] *Id.* at Art. 212.
[160] See e.g., Rio Declaration on Environment and Development, A/CONF.151/26 (Vol. I), Principle 21 (1992), https://www.un.org/en/development/desa/population/migration/generalassembly/docs/globalcompact/A_CONF.151_26_Vol.I_Declaration.pdf; International Law Commission, Articles on Prevention of Transboundary Harm from Hazardous Activities (2001), https://legal.un.org/ilc/texts/instruments/english/draft_articles/9_7_2001.pdf; Stockholm Declaration, *supra* note 146, at Princ. 21; ICJ, *Legality of the Threat or Use of Nuclear Weapons, Advisory Opinion,* 1996 I.CJ. 226, 241-242, ¶ 29.
[161] Convention, *supra* note 1, at Art. (2) ("States shall take all measures necessary to ensure that activities under their jurisdiction or control are so conducted as not to cause damage by pollution to other States and their environment[.]").
[162] International Law Commission, *supra* note 160, at Art. 3.
[163] Convention, *supra* note 1, at Art. 235(3) ("With the objective of assuring prompt and adequate compensation in respect of all damage caused by pollution of the marine environment, States shall cooperate in the implementation of existing international law and the further development of international law relating to responsibility and liability for the assessment of and compensation for damage and the settlement of related disputes, as well as, where appropriate, development of criteria and procedures for payment of adequate compensation, such as compulsory insurance or compensation funds.").
[164] Jason Hickel, *Quantifying National Responsibility for Climate Breakdown: An Equality-based Attribution Approach for Carbon Dioxide Emissions in Excess of the Planetary Boundary*, 4 Lancet Planet Health e399, e399 (2020), https://www.thelancet.com/action/showPdf?pii=S2542-5196%2820%2930196-0.

climate change in 2019 were Mozambique, Zimbabwe, and the Bahamas.[165] Although the cooperation of all State Parties will be necessary to avert catastrophic climate change impacts, the principle of common but differentiated responsibilities reinforces that those nations who played an outsize role in causing the crisis must take a leadership role in addressing its impacts. Along those lines, the polluter pays principle indicates that resources, financial and otherwise, should be provided by those most liable parties for the purpose of addressing the ongoing harms from the climate crisis being felt around the world. These principles of international law will similarly provide important context as the Tribunal makes its determinations in this advisory opinion proceeding.

C. Careful consideration of the best available scientific evidence is crucial in order to adequately interpret the human impacts of climate change as pertinent to the Convention

The Convention's primary concern with the protection and preservation of the marine environment is inextricably bound with its concern for the health and safety of the human populations who rely on the ocean and its resources. The Preamble to the Convention "*bear[s] in mind*" that a stable and protected marine environment "will contribute to the realization of a just and equitable international economic order which takes into account the interests and needs of mankind as a whole and, in particular, the special interests and needs of developing countries, whether coastal or land-locked[.]"[166] The Convention also defines "pollution of the marine environment" as the introduction of materials into the environment that are "hazards to human health[,]" among other things.[167] Even further, it insists that "necessary measures . . . be taken to ensure effective protection of human life[]" with respect to activities on the seafloor outside the realm of any national jurisdiction. Such provisions demonstrate the Convention's commitment to the protection of humanity's right to have perpetual access to the ocean and its resources (as well as to have protection from marine-based State activities) in keeping with their broader fundamental human rights.

Given these considerations, climate change implicates the Convention not only because it threatens the stability and viability of the marine environment but also because it thereby threatens the stability and viability of human populations across the planet. According to the IPCC, the effects of climate change will most severely harm "coastal dependent livelihoods, [I]ndigenous people, children and the elderly, poor labourers, poor urban dwellers in African cities, and people and ecosystems in the Arctic and Small Island Developing States[.]"[168] For example, warming oceans due to climate change increase the severity and frequency of storms such as cyclones and hurricanes, which disproportionately injure marginalized coastal populations and the particularly vulnerable such as children, the elderly, and the poor.[169] Citizens of several Small Island States, in

---

[165] David Eckstein et al., *Global Climate Risk Index 2021: Who Suffers Most from Extreme Weather Events? Weather-Related Loss Events in 2019 and 2000-2019*, Germanwatch 5 (2021), https://germanwatch.org/sites/default/files/Global%20Climate%20Risk%20Index%202021_1.pdf.
[166] Convention, *supra* note 1, at Preamble.
[167] *Id.* at 1(1)(4).
[168] *IPCC Special Report on 1.5°C*, *supra* note 6, at 44.
[169] Noah Smith, *In a Hurricane, Who's at Risk and Why?*, Direct Relief (Aug. 27, 2020), https://www.directrelief.org/2020/08/in-a-hurricane-whos-at-risk-and-why/#:~:text=19%20case%20rates.-,In%20general%2C%20vulnerability%20is%20greater%20among%20people%20at%20age%20extremes,special%20health%20or%20medical%20needs.

particular, are at risk of not only losing their homes and property but also the very physical existence of their nations as viable places to live.[170]

Similarly, Arctic communities are slowly watching the demise of their cultural practices and livelihoods due to climate change. For example, sea-ice retreat is severely impacting the Sami people by reducing the number of phytoplankton in the waters of the Arctic Ocean. Phytoplankton form the base of a complex food web upon which marine animals ranging from shrimp to whales rely. In addition, disappearing sea ice habitat for many other marine animals such as seals, polar bears, and walruses makes it difficult for them to survive.[171] The Sami people's way of life relies on these animals and is thereby threatened by accelerating ice melt due to climate change.

Along similar lines, coral reefs are "are among the most threatened ecosystems on Earth, largely due to unprecedented global warming and climate changes[,]"[172] leading to severe risk for reef-dependent populations. Climate change has several outcomes that lead to the deterioration of coral reef ecosystems. For one, coral reefs in many parts of the world will struggle to repair themselves and grow under certain climate change-induced sea-level rise scenarios.[173] For another, climate change-induced higher water temperatures can stress coral polyps, causing them to bleach and, often, die out entirely.[174] Even further, as oceans absorb more CO_2 from the atmosphere, the ocean becomes more acidic, making it harder for coral polyps to produce and maintain their calcium carbonate exoskeleton substrate.[175] Notably, a recent scientific study taking into account only the effects of ocean warming on corals found that approximately 90% of coral reefs globally will be at severe risk of extinction if planetary warming is allowed to increase to 1.5°C with that figure jumping to 99% at 2.0°C of warming.[176]

Above and beyond these physical impacts on the oceans and coral reefs, a growing body of scientific research shows that climate change can have severe psychological impacts on young people. Studies suggest that extreme heat caused by climate change negatively affects children's mental health as well as their ability to learn.[177] Additionally, traumatic events resulting from climate change such as home disruptions and evacuations—which regularly happen before, during and after coastal disasters such as cyclones—can have significant impacts on children's mental health and development,[178] particularly if those home evacuations become permanent due to

---

170 Chris Parsons, *The Pacific Islands: The Front Line in the Battle against Climate Change*, Nat'l Sci. Found. (May 23, 2022), https://new.nsf.gov/science-matters/pacific-islands-front-line-battle-against-climate.

171 Environmental Justice Foundation, *Rights at Risk: Arctic Climate Change and the Threat to Sami Culture* 5 (2019), https://ejfoundation.org/resources/downloads/EJF-Sami-briefing-2019-final-1.pdf.

172 IUCN, *Coral Reefs and Climate Change*, IUCN Issues Brief 1 (Nov. 2017), https://www.iucn.org/sites/default/files/2022-04/coral_reefs_and_climate_change_issues_brief_final.pdf.

173 Chris Perry, *Loss of Coral Reef Growth Capacity to Track Future Increases in Sea Level*, 558 Nature 396, 396 (2018), https://www.nature.com/articles/s41586-018-0194-z.

174 IUCN, *supra* note 172, at 1.

175 NOAA, *Coral Bleaching and Ocean Acidification Are Two Climate-Related Impacts to Coral Reefs*, Florida Keys National Marine Sanctuary, https://floridakeys.noaa.gov/corals/climatethreat.html.

176 *See, e.g.*, Dixon et al, *supra* note 77, at 5.

177 Frederica Perera & Kari Nadeau, *Climate Change, Fossil-Fuel Pollution, and Children's Health*, 386 New England J. Med. 2303, 2307 https://www.nejm.org/doi/full/10.1056/NEJMra2117706.

178 *See, e.g.*, Daniel Martinez Garcia & Mary C. Sheehan, *Extreme Weather-Driven Disasters and Children's Health*, 46 Int'l J. Health Serv. 79, 88 (2016), https://journals.sagepub.com/doi/abs/10.1177/0020731415625254 ("A cyclone may cause massive breakdowns in urban electric power, potable water, and other service provision over a period of days to weeks, leading to deteriorating living conditions, inaccessible health services, and increased risk of

property damage associated with sea level rise. Growing up with an awareness of the gravity and urgency of climate change has been documented to have a negative impact on young people's psychological well-being, particularly for coastal-dwelling children whose lifestyle and livelihood are centred around the ocean[179] and particularly given the disproportionate lifetime climate impacts children face compare to adults.[180] For example, a literature review of research studies looking at the health impacts of extreme weather disasters on children 18 years of age and younger found that "the cumulative stress brought on by slower-onset but chronic climate-related changes like . . . sea-level rise led to more serious mental health problems including depression and suicidality[]" among children.[181] Even further, a global survey of 10,000 children living in 10 different countries (9 of which are State Parties to the Convention) found that children are experiencing severe emotional distress and anxiety due to climate change. In the survey study, the researchers determined that,

> [C]hildren and young people in countries around the world report climate anxiety and other distressing emotions and thoughts about climate change that impact their daily lives. This distress was associated with beliefs about inadequate governmental response and feelings of betrayal. A large proportion of children and young people around the world report emotional distress and a wide range of painful, complex emotions (sad, afraid, angry, powerless, helpless, guilty, ashamed, despair, hurt, grief, and depressed). Similarly, large numbers report experiencing some functional impact and have pessimistic beliefs about the future (people have failed to care for the planet; the future is frightening; humanity is doomed; they won't have access to the same opportunities their parents had; things they value will be destroyed; security is threatened; and they are hesitant to have children)."[182]

VI. Remedies

The importance of this Tribunal's findings and decisions in the current advisory opinion proceeding cannot be overstated. It is vital that the Tribunal act decisively within the limited time available to protect humanity from egregious climate harms. Given the impending potential for locked-in, long-term alterations to fundamental ocean systems, the Tribunal's determinations in this proceeding are both timely and urgent. There is abundant evidence of both existing violations

---

waterborne and foodborne disease and secondary infection. In [such] cases, the youngest may be particularly vulnerable . . . Surviving a [cyclone] may bring psychological trauma. Because healthy early child development is crucial for physical, emotional, and mental health throughout the lifespan,[] such an experience in early life may have marked effects on later development.[]").

[179] *See, e.g.*, Susie E. L. Burke et al., *The Psychological Effects of Climate Change on Children*, 20 Current Psychiatry Rep. 35, 38-39 (2018), https://pubmed.ncbi.nlm.nih.gov/29637319/ (describing how a high-school student in the Cook Islands worries that "[w]ith climate change and the contribution of human behaviours, our marine eco-system could perish and not be able to provide food, jobs, and income for locals[]").

[180] *See generally* Wim Thiery et al., *Intergenerational Inequities in Exposure to Climate Extremes*, 374 Science 158 (2021), https://www.science.org/doi/10.1126/science.abi7339 (noting the drastically increased severity and frequency of climate change-induced hazards and extremes for younger generations in comparison to older generations).

[181] Burke et al., *supra* note 179, at 37.

[182] Caroline Hickman et al., *Climate Anxiety in Children and Young People and Their Beliefs About Government and Responses to Climate Change: A Global Survey*, 5 Lancet Planetary Health e863, e870 (2021).

of the Convention as well as meaningful though dwindling opportunities to prevent their worsening. Given this context and its urgency, the Tribunal's findings will serve as bellwether for domestic, regional, and international legal systems around the world that are tasked with deciding similar climate cases. The consequential decisions this Tribunal makes—together with findings of other courts and political actors who turn to the Tribunal's expertise and judicial precedent—in relation to the current advisory opinion proceeding will help "determine the future of humanity for the next 10,000 years."[183]

In the exceptional circumstances of the climate crisis, the best available science presented in this submission provides the Court with a solid evidentiary basis for making the following findings:

a. State obligations under the Convention to "protect and preserve the marine environment[;]"[184] to take "all measures consistent with the Convention that are necessary to prevent, reduce or control pollution of the marine environment from any source[;]"[185] and, particularly, "to adopt laws and regulations to prevent, reduce and control pollution of the marine environment from or through the atmosphere"[186] encompass the duty to stabilize Earth's climate system.
b. States' actions to address human-caused climate change must be based on the best available scientific evidence which indicates that restoring Earth's energy balance will require States to pursue pathways to reduce atmospheric CO_2 concentrations from current levels to 350 ppm as rapidly as possible.
c. States whose laws, policies, and commitments are not aligned with achieving the 350 ppm limit must take specific, immediate, and adequate measures to phase out emissions of CO_2 and other greenhouse gas pollution and to remove CO_2 from the atmosphere as necessary to stabilise the climate system for the protection and preservation of marine ecosystems and the ocean as a whole.
d. Certain populations, including children of Small Island States, coastal-communities, and Arctic populations, are particularly at risk due to the impacts of human-caused climate change, and State failures to reduce greenhouse gas pollution and atmospheric CO_2 in accordance with the best available climate science put those populations at increased risk of harm from subsequent deterioration to the marine environment and long-standing oceanic systems.
e. State Parties are liable under Articles 139 and 235 for the damage caused by their failures to "protect and preserve the marine environment"[187] in the context of climate change.

VII. Conclusion

[183] Sarah Naima Roller, *Cambridge To Explore Options for Climate Repair in New Research Centre*, Varsity (May 23, 2019), https://www.varsity.co.uk/news/17528 (quoting Sir David King, the UK Government's Chief Scientific Advisor from 2000 to 2007 and the UK's permanent Special Representative for Climate Change from September 2013 until March 2017).
[184] Convention, *supra* note 1, at Art. 192.
[185] *Id.* at 194.
[186] *Id.* at 212.
[187] *Id.* at 192.

As the only entity authorized to officially interpret the Convention on the Law of the Sea, the Tribunal has the crucial responsibility to determine State Party obligations to safeguard oceans and marine ecosystems in the face of the threat of climate change – a threat that they helped bring into being. Oceans and marine ecosystems are on the front lines of the climate crisis as are the human populations who rely on them for their lives and livelihoods. The current advisory opinion proceeding presents the Tribunal with an opportunity to lead the effort to address a global challenge unlike any the world has ever faced. By making a definitive decision informed by and relying on the best available science, the Tribunal will join a growing judicial movement[188] and play a *leading* and *pivotal* role in making the critical shift toward scientifically informed climate law and policy. This moment affords the Tribunal the chance not only to protect our crucial ocean habitats but also to vindicate those most affected by climate change: our children and young people. A decision in accordance with science would have significant, positive ripple effects around the world and would set a leading legal precedent underscoring that the time has come for every State not just to aim to do their best but, instead, to do what is scientifically required to comply with their obligations under the Convention in efforts to avoid catastrophic climate outcomes.

Respectfully submitted by,

Kelly Matheson
Deputy Director of Global Climate Litigation
Our Children's Trust

Paul Rink
Global Staff Attorney
Our Children's Trust

Nafkote Dabi
Climate Policy Lead
Oxfam International

Joss Saunders
General Counsel
Oxfam International

Ashfaq Khalfan
Director, Climate Justice
Oxfam America

[188] *See, e.g.*, *In re Hawai'i Electric Light Company, Inc.*, 526 P.3d 329 (2023) http://climatecasechart.com/wp-content/uploads/sites/16/case-documents/2023/20230313_docket-SCOT-22-0000418_opinion-2.pdf.

VIII. Annex I – Critical Scientific Studies

This Annex presents a curated bibliography of the most critical scientific studies by subject and with links[189] for the Tribunal's consideration. These studies are relied on and cited in the accompanying submission. Further information with respect to the qualifications of many of the scientific experts cited to within is available upon request.

History of Climate Science and Policy

University Corporation for Atmospheric Research: Centre for Science Education, *History of Climate Science Research* (2022), https://scied.ucar.edu/learning-zone/how-climate-works/history-climate-science-research.
Synopsis: This peer reviewed, interactive web-based resource, developed in collaboration with the U.S. National Science Foundation's National Centre for Atmosphere Research, includes a detailed timeline for the historical development of scientific knowledge regarding the phenomenon of climate change.

Andrea Rodgers, Lauren Sancken, & Jennifer Marlow, *The Injustice of 1.5˚C–2˚C: The Need for a Scientifically Based Standard of Fundamental Rights Protection in Constitutional Climate Change Cases*, 40 Va. Env't L. J. 102 (2022), http://www.velj.org/uploads/1/2/7/0/12706894/40.2_va_envt_l.j._rodgers_sancken_marlow_102_151.pdf.
Synopsis: This law review article articulates how the politically negotiated Paris temperature targets rose to prominence as a standard for climate action and why a scientifically based legal standard for action must be used instead to adequately protect human rights.

Impacts at 1.5-2.0ºC

David Armstrong McKay and 9 Others, *Exceeding 1.5°C Global Warming Could Trigger Multiple Climate Tipping Points*, 377 Sci. 1 (2022), https://www.science.org/doi/10.1126/science.abn7950.
Synopsis: This scientific article identifies a series of irreversible tipping points in Earth's climate system that are increasingly likely to be triggered as global average surface temperature increases to 1.5ºC or 2.0ºC above pre-industrial levels, leading to dramatic and difficult to predict consequences for Europe and all other regions of the world.

Johan Rockström and 50 Others, *Safe and Just Earth System Boundaries*, Nature 1 (2023), https://www.nature.com/articles/s41586-023-06083-8.
Synopsis: This study quantifies the human impacts of various Earth system boundaries and determines that the just boundary for avoiding significant harm to tens of billions of people should be set at or below 1.0°C of average surface temperature increase above pre-industrial times.

Ocean Warming

Charlotte Laufkötter and 2 Others, *High-Impact Marine Heatwaves Attributable to Human-*

[189] If for any reason a study cannot be accessed online, they are all available upon request.

Induced Global Warming, 369 Science 1621 (2020), https://www.science.org/doi/10.1126/science.aba0690.
Synopsis: This article notes that periods of anomalously high regional ocean temperatures, and their resulting negative impacts to marine ecosystems, are correlated with rising global temperatures and will become increasingly frequent with additional planetary heating.

Mika Rantanen and 7 Others, *The Arctic Has Warmed Nearly Four Times Faster Than the Globe Since 1979,* 3 Commc'n Earth Env't 168 (2022), https://doi.org/10.1038/s43247-022-00498-3.
Synopsis: This scientific study determines that the Arctic region is heating up much faster than the rest of the planet and much faster than would seem likely based on many prominent climate models.

Niklas Boers and Martin Rypdal, *Critical Slowing Down Suggests That the Western Greenland Ice Sheet Is Close to a Tipping Point,* 118 Proc. Nat'l Acad. Sci.: Earth, Atmospheric, & Planetary Sciences 21 (2021), https://doi.org/10.1073/pnas.2024192118.
Synopsis: This scientific article indicates that self-reinforcing mechanisms within the Greenland ice sheet threaten to push it into a state of accelerating and irreversible melting.

Dan A. Smale and 17 Others, *Marine Heatwaves Threaten Global Biodiversity and the Provision of Ecosystem Services*, 9 Nature Climate Change 306 (2019), http://passage.phys.ocean.dal.ca/~olivere/docs/Smale_2019_NCC_MHWsBiodiversityEcosystemServices.pdf.
Synopsis: This scientific article provides evidence that marine heatwaves will intensify with additional global warming, causing severe disturbances that fundamentally reconstitute marine ecosystems and undermine the services they provide over the course of decades.

<u>Climate Impacts to Marine Ecosystems</u>

Adele M. Dixon and 4 Others, *Future Loss of Local-Scale Thermal Refugia in Coral Reef Ecosystems*, 1 PLOS Climate e0000004 (2022) https://journals.plos.org/climate/article?id=10.1371/journal.pclm.0000004.
Synopsis: This scientific study determines that warming of 1.5°C will all but eliminate thermal refugia for coral reef ecosystems putting most of the world's coral reefs at risk of extinction.

Christopher J. Gobler, *Climate Change and Harmful Algal Blooms: Insights and Perspective*, 91 Harmful Algae 1 (2020), https://www.sciencedirect.com/science/article/pii/S1568988319302045.
Synopsis: This scientific article finds that climate change-induced ocean warming has contributed to increased incidence of harmful algal blooms in the past few decades, leading to adverse outcomes for food security, tourism, local economies, and human health.

Joaquim Garrabou et al., *Marine Heatwaves Drive Recurrent Mass Mortalities in the Mediterranean Sea*, 28 Global Change Biology 5708 (2022), https://onlinelibrary.wiley.com/doi/full/10.1111/gcb.16301.
Synopsis: This study indicates that the frequency and severity of marine heatwaves is increasing due to climate change, leading to higher rates of mass mortality events for marine organisms and

fundamentally threatening the health and functioning of numerous marine ecosystems.

Earth Energy Imbalance

Karina von Schuckmann and 37 Others, *Heat Stored in the Earth System: Where Does the Energy Go?*, 12 Earth Sys. Sci. Data 2013 (2020), https://essd.copernicus.org/articles/12/2013/2020/essd-12-2013-2020.pdf.
Synopsis: This scientific study makes it clear that Earth's energy imbalance is the most accurate and reliable metric for measuring the extent of global warming and that the only way to stabilise Earth's energy balance is to bring atmospheric CO_2 concentrations back down to less than 350 ppm. It further determines that the majority (about 90%) of Earth's excess heat accumulates in the ocean.

Emission Reductions & Means

James Hansen and 14 Others, *Young People's Burden: Requirement of Negative CO_2 Emissions*, 8 Earth Sys. Dynamics 577 (2017), https://esd.copernicus.org/articles/8/577/2017/
Synopsis: This scientific article clarifies that limiting the climate harms experienced by young people throughout their lives will require not only immediate and drastic reductions in GHG pollution but also the removal of CO_2 from the atmosphere down to the 350 ppm level.

Mark Jacobson and 6 Others, *Low-cost Solutions to Global Warming, Air Pollution, and Energy Insecurity for 145 Countries*, 15 Energy & Env't Sci. 3343 (2022),
https://web.stanford.edu/group/efmh/jacobson/Articles/I/145Country/22-145Countries.pdf
Synopsis: This scientific study provides roadmaps for 145 countries around the world to transition from current fossil fuel based energy systems to 100% renewable energy sources that emit no GHGs by 2050.

Christian Breyer and 22 Others, *On the History and Future of 100% Renewable Energy Systems Research*, 10 IEEE Access 78176 (2022),
https://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=9837910
Synopsis: This meta-analysis surveys and analyses numerous scientific studies that determine a transition to 100% renewable energy is feasible globally at low cost.

Natural Carbon Removal and Drawdown

Pete Smith and 17 Others, *How to Measure, Report and Verify Soil Carbon Change to Realize the Potential of Soil Carbon Sequestration for Atmospheric Greenhouse Gas Removal*, 26 Glob. Change Biology 219, (Aug. 2019),
https://doi.org/10.1111/gcb.14815
Synopsis: This study examines methods to measure and manage soils to support and grow national and international climate initiatives to use soils to mitigate climate change.

Bronson W. Griscom and 31 Others, *Natural Climate Solutions,* 114 Earth, Atmospheric, and Planetary Sciences 11645 (2017),

https://doi.org/10.1073/pnas.1710465114
Synopsis: This comprehensive analysis identifies 20 natural climate solutions via conservation, restoration, and improved land management actions that increase carbon storage and/or avoid greenhouse gas emissions across global forests, wetlands, grasslands, and agricultural lands.

Health & Children

Caroline Hickman and 8 Others, *Climate Anxiety in Children and Young People and Their Beliefs About Government and Responses to Climate Change: A Global Survey*, 5 Lancet Planet Health e863 (2021),
https://www.thelancet.com/action/showPdf?pii=S2542-5196%2821%2900278-3
Synopsis: This comprehensive survey study identifies high levels of climate anxiety for young people in ten countries around the world, including widespread feelings of fear, powerlessness, and betrayal by the governments entrusted to protect them.

Frederica Perera & Kari Nadeau, *Climate Change, Fossil-Fuel Pollution, and Children's Health*, 386 New England J. of Med. 2303 (2022),
https://www.nejm.org/doi/pdf/10.1056/NEJMra2117706
Synopsis: This review article provides a comprehensive summary of the best available and up-to-date scientific research on the harms that climate change and fossil fuel combustion impose on children.

Wim Thiery and 36 Others, *Intergenerational Inequities in Exposure to Climate Extremes*, 374 Science 158 (2021), https://www.science.org/doi/10.1126/science.abi7339
Synopsis: This study quantifies lifetime exposure to climate impacts across generational cohorts and determines that those born in 2020 will experience two to seven times more extreme weather events than those born in 1960.