

WEATHERING THE STORM OF GLOBAL CLIMATE LITIGATION: ENABLING JUDGES TO MAKE SENSE OF SCIENCE

SANDRA NICHOLS THIAM,* JARRYD C. PAGE,[†] JOHN M. DOHERTY,[‡] AND
TIM NAU[§]

ABSTRACT

Across the world, judges are increasingly being asked to make decisions on litigation related to climate change. As climate impacts increase in severity over the coming decades, more cases are certain to follow. These cases sometimes require judges to understand both the basic, well-established principles of climate science in addition to cutting-edge techniques in climate change attribution—a rapidly growing scientific field that seeks to identify the link, if any, between greenhouse gas emissions of a given source and the occurrence or impacts of a particular weather event. Here, we introduce the general concepts of climate science and climate change attribution and discuss the relevance of these scientific topics to select high-profile cases that have been brought before various national and international judicial bodies.

Moreover, judicial education plays a critical role in preparing judges for emerging issues relevant to their dockets. The growing number of climate cases suggests climate science is one such issue. To help judges make sense of climate science and its relevance, the Environmental Law Institute's Climate Judiciary Project is taking steps to bridge the divide between scientists and judges through specialized educational programming on several climate science topics. These

* Sandra Nichols Thiam, JD (University of Virginia), is Vice President of Research and Policy and Director of Judicial Education at the Environmental Law Institute. Thiam works to promote rule of law and good governance, advising governments on comparative best practices, and designing and implementing training programs for a broad spectrum of stakeholders. © 2024, Sandra Nichols Thiam, Jarryd C. Page, John M. Doherty, and Tim Nau.

[†] Jarryd C. Page, JD (The George Washington University Law School), works at the intersection of climate change, policy research, and education. He is a Staff Attorney at the Environmental Law Institute with experience in both U.S. and international environmental law and policy issues.

[‡] Dr. John M. Doherty is a geoscientist working at the intersection of climate science, law, and judicial education. He is the Science Fellow at the Environmental Law Institute's Climate Judiciary Project. Dr. Doherty holds a Ph.D. in Earth Sciences, an M.S. in Environmental Science, and a B.A. in Political Theory.

[§] Tim Nau, M. Jur. (University of Münster), LL.M. (The George Washington University Law School) was a Visiting Researcher and Law Clerk at the Environmental Law Institute and is currently a Legal Research Assistant with the Chair for US Law, Professor Dr. Kirk W. Junker, at the University of Cologne, Germany.

efforts provide judges with the information and tools that they need to make informed decisions on the storm of litigation coming to their courtrooms, wherever they may be.

I.	INTRODUCTION	564
II.	A REVIEW OF CLIMATE SCIENCE AND WHAT HAPPENS WHEN IT MEETS THE LAW	565
	A. <i>Climate Science and Climate Change Attribution</i>	566
	B. <i>How Climate Science and the Law Collide</i>	570
III.	CLIMATE SCIENCE IN COURT CASES	572
	A. <i>Upcoming Opportunities to Grapple with Climate Science in Tribunals with International Jurisdiction</i>	572
	1. Advisory Opinions	573
	2. Climate Science Informs International Criminal Court Communication	576
	B. <i>Climate Cases Already Involve Climate Science</i>	578
	1. United States	578
	2. The Netherlands	582
	3. Germany	584
IV.	PREPARING THE COURTS: CLIMATE SCIENCE EDUCATION FOR JUDGES	590
V.	CONCLUSION	592

I. INTRODUCTION

Recent years have seen a growing number of court cases involving material issues of law, fact, or policy related to climate change.¹ Although most cases are filed in U.S. courts, they are also increasingly being brought before national jurisdictions of other countries and international tribunals.² While international tribunals have not yet

1. See generally Jacqueline Peel & Hari M. Osofsky, *Climate Change Litigation*, 16 ANN. REV. L. & SOC. SCI. 21 (2020) (reviewing literature involving climate litigation); JOANA SETZER & CATHERINE HIGHAM, GLOBAL TRENDS IN CLIMATE LITIGATION: 2023 SNAPSHOT (2023) (providing overview of key trends); MICHAEL BURGER & MARIA ANTONIA TIGRE, GLOBAL CLIMATE LITIGATION REPORT: 2023 STATUS REVIEW (2023); Sabrina McCormick et al., *Science in Litigation: The Third Branch of U.S. Climate Policy*, 357 SCI. 979 (2017).

2. As of June 2023, the Sabin Center for Climate Change Law reported more than 1,600 cases in the U.S. Climate Change Litigation database and more than 735 cases in the Global Climate Change Litigation database. These numbers reflect the database’s definition of climate litigation, which is limited to cases brought before judicial bodies and where climate change law, policy, or science, is a material issue of law or fact. According to the website, the “database is not exhaustive. Key limitations include language barriers, levels of media coverage, and public availability of court documents. . . . Similarly, the fact that no climate litigation has yet been identified in a given

seen a significant number of climate cases, the cases that have been brought are potentially of high consequence.

The technical details of climate science underpin the legal arguments in several climate cases. Climate science is a diverse field that, among other topics, investigates Earth's climate system, how it is changing, how these physical changes are impacting human and natural systems, and how much of the change and its consequent impacts can be attributed to a specific source, sector, or activity. As such, judiciaries across the world are likely to encounter a growing number of disputes that require familiarity with the findings and methodologies of climate science. As with other emerging issues, a prepared judiciary can be a capable judiciary.³ In a survey of judiciaries across the EU, respondents from Estonia, Spain, Bulgaria, Serbia, and Portugal, emphasized that more training and specialization related to climate litigation is needed.⁴ This Article presents some of the challenges and opportunities for the growing intersection between science and law in climate litigation and highlights examples of how climate science has already arisen in climate litigation.⁵

II. A REVIEW OF CLIMATE SCIENCE AND WHAT HAPPENS WHEN IT MEETS THE LAW

Many high-profile climate cases involve scientific evidence that identifies the causes of climate change, its impacts, and its attribution to an actor, sector, or activity. In this part, we introduce concepts from the science of climate change attribution and compare methods of fact-finding in science and law, highlighting some of the challenges in bridging the two disciplines.

jurisdiction should not be taken as a certain indication that no such litigation has been filed or decided." *About*, CLIMATE CHANGE LITIG. DATABASES: SABIN CTR. CLIMATE CHANGE L., <http://climatecasechart.com/about/> (last visited July 7, 2023).

3. Joe S. Cecil, *Science Education for Federal Judges*, AM. BAR ASSOC. (Nov. 1, 2017), https://www.americanbar.org/groups/judicial/publications/judges_journal/2017/fall/science-educatifiedederal-judges/ (reporting on the importance of Federal Judicial Center science education programming "to ensure that judges are prepared to meet the challenges of a complex and rapidly evolving culture.").

4. JOANA SETZER ET AL., CLIMATE LITIGATION IN EUROPE: A SUMMARY REPORT FOR THE EUROPEAN UNION FORUM OF JUDGES FOR THE ENVIRONMENT 19 (2022), https://www.lse.ac.uk/granthaminstitute/wp-content/uploads/2022/12/Climate-litigation-in-Europe_A-summary-report-for-the-EU-Forum-of-Judges-for-the-Environment.pdf.

5. The survey of cases presented here is not intended to be comprehensive, but rather to illustrate some of the ways in which climate science has come to bear on the law.

A. *Climate Science and Climate Change Attribution*

Progress in climate science has enabled litigation related to mitigation and adaptation around the world. In these climate cases, the Intergovernmental Panel on Climate Change (IPCC) is a common source of scientific information. Created in 1988, the IPCC assesses the state of scientific knowledge about climate change and “provide[s] governments at all levels with scientific information that they can use to develop climate policies.”⁶ As of 2024, the IPCC has representation from 195 member countries. The result of this effort is a regularly published, comprehensive, and authoritative assessment report.⁷ Because climate science is an inherently multidisciplinary enterprise, these reports are written by hundreds of leading climate scientists from around the world, with different domains of expertise, including geology, atmospheric physics, oceanography, agricultural science, health science, and ecology, among others.⁸ The IPCC separates assessment reports into three sections, termed “working groups,” that review the full breadth of scientific evidence around the physical basis of climate change, its impacts, and possible solutions to the challenges it poses.⁹ On occasion, the IPCC also releases “special reports” that investigate specific areas of interest, such as the Special Report on Global Warming of 1.5°C.¹⁰

This global and comprehensive assessment of all aspects of the science related to climate change has made the IPCC the world’s leading authority on climate science. In its 1990 First Assessment Report (FAR),

6. *About the IPCC*, INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE [IPCC], <https://www.ipcc.ch/about/> (last visited June 30, 2023); *see also* G.A. Res. 43/53, ¶ 5 (Dec. 6, 1988) (writing with “concern[] that certain human activities could change global climate patterns, threatening present and future generations with potentially severe economic . . . consequences” and “endorses [ing] the action of the World Meteorological Organization and the United Nations Environment Programme in jointly establishing an Intergovernmental Panel on Climate Change to provide internationally coordinated scientific assessments of the magnitude, timing and potential environmental and socio-economic impact of climate change and realistic response strategies”).

7. Since publication of the First Assessment Report in 1990, there have been five more. The latest, the Sixth Assessment Report (“AR6”), was released in 2021 and 2022, with the AR6 Synthesis report released in 2023. *See* IPCC, AR6 SYNTHESIS REPORT: CLIMATE CHANGE 2023 (2023) [hereinafter AR6 SYNTHESIS REPORT], https://www.ipcc.ch/report/ar6/syr/downloads/report/IPCC_AR6_SYR_FullVolume.pdf.

8. For the information of the authors, *see Author*, IPCC, <https://apps.ipcc.ch/report/authors/> (last accessed Nov. 6, 2023).

9. *See About the IPCC*, *supra* note 6.

10. *See* IPCC, GLOBAL WARMING OF 1.5°C (2018), https://www.ipcc.ch/site/assets/uploads/sites/2/2022/06/SR15_Full_Report_HR.pdf; *see also* IPCC, SPECIAL REPORT ON THE OCEAN AND CRYOSPHERE IN A CHANGING CLIMATE (2019), https://www.ipcc.ch/site/assets/uploads/sites/3/2022/03/SROCC_FullReport_FINAL.pdf.

the IPCC noted that human emissions of heat-trapping greenhouse gases (GHGs), such as carbon dioxide (CO₂), would cause global warming,¹¹ a finding well-supported by individual scientists for the past several decades.¹² Over 30 years later, the IPCC's Sixth Assessment Report (AR6) found that "[i]t is unequivocal that human influence has warmed the atmosphere, ocean and land."¹³ The 2021 report continued, "[h]uman-induced climate change is already affecting many weather and climate extremes in every region across the globe."¹⁴ The field of attribution science—a field that is also featured in climate litigation—makes such conclusions possible.

As in the law, the attribution of effects to causes is a central issue in climate science. Attribution science is a multistep exercise in determining the causality that first links emissions to climate change, then links climate change to climate impacts, such as certain extreme weather events.¹⁵ A scientific consensus has found that global average surface temperature has risen by about 1.1°C above pre-industrial levels as of 2021 due to human activity, notably from emissions of GHGs associated with burning fossil fuels for energy, agriculture, and land-use change.¹⁶ This conclusion is based on decades of direct observations of the planet's climate system—its lands, waters, ice, atmosphere, and biosphere—and climate models.¹⁷

Climate models are mathematical descriptions of the physical processes that govern the Earth's climate.¹⁸ The late climate scientist and National Aeronautics and Space Administration (NASA) astronaut Dr. Piers Sellers said that "[c]limate models are made out of theory . . .

11. IPCC, CLIMATE CHANGE: THE IPCC SCIENTIFIC ASSESSMENT (1990), https://archive.ipcc.ch/ipccreports/far/wg_I/ipcc_far_wg_I_full_report.pdf.

12. See Spencer Weart, *The Discovery of Global Warming [Excerpt]*, SCI. AM. (Aug. 17, 2012), <https://www.scientificamerican.com/article/discovery-of-global-warming/> (excerpting a portion of SPENCER WEART, *THE DISCOVERY OF GLOBAL WARMING* (Harvard Univ. Press, 2008)).

13. RICHARD P. ALLEN ET AL., SUMMARY FOR POLICYMAKERS 4 (2021), https://report.ipcc.ch/ar6/wg1/IPCC_AR6_WGI_FullReport.pdf.

14. *Id.* at 8.

15. See Michael Burger et al., *The Law and Science of Climate Change Attribution*, 45 COLUM. J. ENV'T L. 57, 66 (2020).

16. AR6 SYNTHESIS REPORT, *supra* note 7, at 4-5, 42.

17. See *generally id.*, (and accompanying text).

18. See Robert McSweeney & Zeke Hausfather, *Q&A: How Do Climate Models Work?*, CARBONBRIEF (Jan. 15, 2018), [https://www.carbonbrief.org/qa-how-do-climate-models-work/#:~:text=At%20their%20most%20basic%20level,couered%20regions%20of%20the%20planet](https://www.carbonbrief.org/qa-how-do-climate-models-work/#:~:text=At%20their%20most%20basic%20level,couered%20regions%20of%20the%20planet;); see also PAUL HANLE & MICHAEL MASTRANDREA, ENV'T L. INST., CLIMATE SCIENCE AND LAW FOR JUDGES: HOW CLIMATE SCIENCE WORKS (2023).

turned into computer code[.]”¹⁹ That is, they translate the well-established laws of physics into computer code, enabling a skillful simulation of the state of the climate at a given point in time based on changes in certain climate variables such as solar output, aerosols, and GHG emissions, among others.²⁰ Climate models are useful because, unlike scientists in other disciplines, climate scientists do not have physical replicates of the planet on which to perform experiments.

Modeling allows scientists to run simulated experiments on the world as-is and on a counterfactual world without human activity, which lets them answer questions such as, “Did human activity play a role in post-industrial global warming?”²¹ Based on the simulations from over 100 climate models run by independent research groups that contributed to the latest IPCC report, the answer to that question is an unequivocal “yes.”²² In fact, the observed warming trend would not be possible but for the existence of human activity, as natural factors alone would cause the planet to cool instead of warm.²³

Models also allow scientists to interrogate climate-induced changes in both the severity and probability of certain extreme weather events, such as coastal flooding, by comparing the world with climate change (as-is) and counterfactual simulations of the world without climate change.²⁴ By simulating these events under future levels of potential climate change, models can be used to anticipate future climate risks given various GHG emissions scenarios. The ability to anticipate climate-induced risk raises legal and policy issues, such as questions of what impacts from certain natural disasters are foreseeable in a warmer world.

In some instances, scientists can take a more granular attribution approach, linking individual weather events to climate change. This area of research is termed “event attribution,” which includes *extreme*

19. Piers Sellers, *Space, Climate Change, and the Real Meaning of Theory*, NEW YORKER (Aug. 17, 2016), <https://www.newyorker.com/tech/annals-of-technology/space-climate-change-and-the-real-meaning-of-theory>.

20. See Zeke Hausfather et al., *Evaluating the Performance of Past Climate Model Projections*, 47 GEOPHYSICAL RSCH. LETTERS 1, 1 (2019); see also McSweeney & Hausfather, *supra* note 18.

21. McSweeney & Hausfather, *supra* note 18.

22. See AR6 SYNTHESIS REPORT, *supra* note 7, at v (“confirm[ing] that unsustainable and unequal energy and land use as well as more than a century of burning fossil fuels have unequivocally caused global warming[.]”) (emphasis added).

23. See Zeke Hausfather, *Analysis: Why Scientists Think 100% of Global Warming is Due to Humans*, CARBON BRIEF (Dec. 13, 2017, 4:59 PM), <https://www.carbonbrief.org/analysis-why-scientists-think-100-of-global-warming-is-due-to-humans/#:~:text=Carbon%20Brief%27s%20analysis%20finds%20that,warming%20than%20has%20actually%20occurred>.

24. See Burger et al., *supra* note 15, at 71.

event attribution, or the attribution of extreme weather events such as heatwaves and floods.²⁵ However, individual extreme event attribution studies might take years to complete, delaying potentially key pieces of evidence that judges might otherwise rely on to make informed decisions. To help resolve this timing issue,²⁶ the World Weather Attribution initiative developed a peer-reviewed methodology for more rapid attribution analyses in the immediate aftermath of, or even during, extreme weather events.²⁷

Understanding the influence of climate change on extreme weather events is an important component for assessing the impacts of climate change on human and natural systems, but it is not the only component. An event attribution study might indicate that a deadly heat wave was made more likely by climate change, but non-climate variables, such as access to cooling and underlying health conditions, may contribute to the number of deaths caused by that heatwave.²⁸ Such studies may end up playing critical roles in lawsuits alleging damages related to heatwaves.²⁹ The type of research known as “impact attribution” aims to isolate the influence of climate change from other factors on the impact of these events,³⁰ and thus, the research is similarly likely to play a major role in lawsuits that allege damages caused by climate change.

The question of responsibility for climate change and its impacts, as the final step in the causal chain, is certain to continue to arise in climate litigation. “Source attribution” aims to link the emissions from a

25. *Id.* at 67 (“discuss[ing] *extreme event attribution* as a separate category of attribution research. This is because extreme events do not fit neatly into the ‘climate change attribution’ or ‘impact attribution’ categories.”) (emphasis in original).

26. See Lois Parshley, *When Disaster Strikes, Is Climate Change to Blame?*, SCI. AM. (June 1, 2023), <https://www.scientificamerican.com/article/when-disaster-strikes-is-climate-change-to-blame/> (noting that the World Weather Attribution’s new methodology was primarily meant to address the lag between a weather event and the results of an attribution study).

27. See Geert Jan van Oldenborgh et al., *Pathways and Pitfalls in Extreme Event Attribution*, 166 CLIMATIC CHANGE 1, 1 (2021); see also Sjoukje Philip et al., *A Protocol for Probabilistic Extreme Event Attribution Analyses*, 6 NATURE ADVANCES STAT. CLIMATOLOGY, METEOROLOGY & OCEANOGRAPHY 177 (2020); WORLD WEATHER ATTRIBUTION, <https://www.worldweatherattribution.org/> (last visited July 14, 2023); see also Parshley, *supra* note 26 (noting that the work of the World Weather Attribution was a factor in at least one court decision in Australia).

28. See generally Burger et al., *supra* note 15, at 88-110 (discussing extreme event attribution, including extreme heat, drought, heavy precipitation, and tropical and extratropical cyclones).

29. See, e.g., Compl., County of Multnomah v. Exxon Mobil Corp. 4 (Or. Cir. Ct. June 22, 2023) (citing Philip Y. Sjoukje et al., *Rapid Attribution Analysis of the Extraordinary Heat Wave on the Pacific Coast of the US and Canada in June 2021*, 13 EARTH SYS. DYNAMICS 1689-1713 (2022)).

30. See Burger et al., *supra* note 15, at 111-16.

particular source of GHG emissions to climate change and its impacts.³¹ A source could be an actor, such as a country or company, a sector, such as agriculture, or an activity, such as an international flight.³² In lawsuits against governments and private companies, plaintiffs argue (with varying degrees of success) that these sources should be held accountable for climate-related damages, as discussed below.³³ Because GHGs are well-mixed in the atmosphere, one reasonable method for assessing a source's contribution to climate change is to calculate that source's proportional emissions relative to total human emissions. This approach will be seen in most of the cases outlined in Part III below.

B. *How Climate Science and the Law Collide*

Judges and scientists alike weigh evidence and use reason to come to their conclusions. However, while the law seeks to arrive at a decision with some degree of finality, those decisions are limited to a certain factual context, while science is an open-ended process that aims to understand the objective reality of the natural world with better precision over time and, importantly, is unconstrained by court deadlines.³⁴

Judges consider scientific evidence when available and appropriate, but time constraints and a host of other factors make it impossible, and indeed not desirable, for judges to fully investigate the natural world through the scientific method. As U.S. Supreme Court Justice Stephen Breyer put it, “[t]he search is not a search for scientific precision. We cannot hope to investigate all the subtleties that characterize good scientific work.”³⁵ He recognized, though, that “[t]he law must seek decisions that fall within the boundaries of scientifically sound knowledge.”³⁶ Such an objective is distinct from the scientific one of acquiring knowledge for knowledge's sake.

31. See, e.g., Richard Heede, *Tracing Anthropogenic Carbon Dioxide and Methane Emissions to Fossil Fuel and Cement Producers, 1854-2010*, 122 CLIMATIC CHANGE 229 (2014); Brenda Ekwurzel et al., *The Rise in Global Atmospheric CO₂, Surface Temperature, and Sea Level from Emissions Traced to Major Carbon Producers*, 144 CLIMATIC CHANGE 579 (2017); RACHEL LICKER ET AL., UNION OF CONCERNED SCIENTISTS, TRACING FOSSIL FUEL COMPANIES' CONTRIBUTION TO CLIMATE CHANGE AND OCEAN ACIDIFICATION: FACT SHEET (2019), https://www.ucsusa.org/sites/default/files/2019-12/UCS_acidification_FS_191210a_low-res.pdf.

32. See Burger et al., *supra* note 15, at 128.

33. See *infra* Part III.

34. See HANLE & MASTRANDREA, *supra* note 18, at 2-4.

35. Stephen Breyer, *Introduction*, in FED. JUDICIAL CTR. & NAT'L RSCH. COUNCIL, REFERENCE MANUAL ON SCIENTIFIC EVIDENCE 1, 4 (3d ed. 2011).

36. *Id.*

Climate scientists and judges also often speak different languages. By definition, climate is the average of weather over time. As such, findings in climate science are often discussed in the language of statistics and probability, which sometimes uses words differently than they are understood in a non-scientific context.³⁷ For example, the word “uncertainty” in science does not mean “we do not know.” Rather, it is a word that describes a full range of possible outcomes that are likely to occur within a quantifiable upper and lower bound.³⁸

The IPCC has translated the language of statistics into a set of calibrated likelihood statements that encompass different levels of certainty.³⁹ The phrase “virtually certain” in IPCC reports indicates that an outcome has a 99-100% probability of being true, and the phrase “extremely likely” indicates a 95-100% probability range.⁴⁰ To contextualize, the AR6 Synthesis Report (AR6 SYR), which summarizes the main findings of the three working groups and other IPCC literature, notes, “[i]t is *virtually certain* that the global upper ocean (0-700m) has warmed since the 1970s and *extremely likely* that human influence is the main driver.”⁴¹

IPCC reports are also replete with parenthetical qualitative statements about the degree of confidence in their findings.⁴² In general, confidence is said to be highest when there are multiple, independent lines of high-quality evidence that all point in the same direction.⁴³ For example, it was found in the IPCC’s AR6 SYR that “[h]uman-caused climate change is already affecting many weather and climate extremes in every region across the globe.”⁴⁴ Quantitative likelihood statements and qualitative confidence statements together can help judges assess the reliability of claims made about climate change and its impacts. However, these

37. See Astrid Kause et al., *Communications about Uncertainty in Scientific Climate-Related Findings: A Qualitative Systematic Review*, 16 ENV’T RSCH. LETTERS 1, 1 (2021) (noting how many of the users of scientific climate-related findings may lack formal training in climate science or related disciplines).

38. See generally MICHAEL D. MASTRANDREA ET AL., IPCC, GUIDANCE NOTE FOR LEAD AUTHORS OF THE IPCC FIFTH ASSESSMENT REPORT ON CONSISTENT TREATMENT OF UNCERTAINTIES (July 6, 2010), https://www.ipcc.ch/site/assets/uploads/2017/08/AR5_Uncertainty_Guidance_Note.pdf.

39. *Id.* at 3.

40. *Id.*

41. AR6 SYNTHESIS REPORT, *supra* note 7, at 46.

42. See, e.g., MASTRANDREA ET AL., *supra* note 38, at 1 (noting that “the AR5 will rely on two metrics for communicating the degree of certainty[.]” and that “[c]onfidence is expressed qualitatively.”).

43. See *id.* at 2-3.

44. AR6 SYNTHESIS REPORT, *supra* note 7, at 42. The report found with *high confidence* that “[t]his has led to widespread adverse impacts on food and water security, human health and on economies and society and related losses and damages to nature and people.” *Id.*

phrases do not always map comfortably onto legal standards, creating potential challenges when judges use climate science evidence.⁴⁵

Judges are also familiar with uncertainty, although that terminology is not necessarily used in the same way it is in the scientific community. Various legal standards of proof are, however, framed in terms of certainty. For example, in the United States, the well-known standards for criminal convictions (“beyond a reasonable doubt”) and most civil cases (“preponderance of the evidence”) demonstrate that the same level of certainty is not always required for each dispute, and in fact, it varies depending on the type of case.⁴⁶ Although these standards have been further articulated over time,⁴⁷ absent from them are statements of confidence. For climate science evidence in climate cases, however, issues of admissibility and reliability have been more relevant. As the cases described below show, the reliability of consensus climate science has been repeatedly reinforced by courts, and climate science evidence has been regularly admitted into climate cases.

III. CLIMATE SCIENCE IN COURT CASES

Climate change litigation has accelerated since the early 2000s.⁴⁸ This part examines the role of science in climate litigation. In tribunals with international jurisdiction, we focus on one prominent criminal accusation and several requests for advisory opinions. In addition, this part outlines some of the most well-known and influential cases from courts in the United States, the Netherlands, and Germany.

A. *Upcoming Opportunities to Grapple with Climate Science in Tribunals with International Jurisdiction*

Climate cases in courts with international jurisdiction are scarce but growing. These cases involve attempts at criminal prosecution of government officials and efforts to seek clarity through advisory opinions on the obligations of states.⁴⁹ Based on the questions the International

45. See Charles Weiss, *Expressing Scientific Uncertainty*, 2 L., PROBABILITY & RISK 25, 41 (2003) (comparing various approaches to uncertainty, including legal and IPCC scales).

46. See *id.* at 31-32 (noting that “several levels of certainty fall within the substantial gap that lies between the ‘criminal’ and the ‘civil’ standards of proof.”).

47. See *id.* at 30-32 (describing the narrative language that accompanies each legal standard).

48. SETZER & HIGHAM, *supra* note 1, at 11 (showing chart with U.S. and non-U.S. cases).

49. The proposal to adopt “ecocide” as a fifth core crime in the Rome Statute has gained traction lately but is beyond the scope of this paper. See, e.g., Darryl Robinson, *Ecocide—Puzzles and Possibilities*, 20 J. INT’L CRIM. JUST. 313 (2022) (surveying issues in defining ecocide); see Sabin Ctr. for Climate Change L., *Advisory Opinions on Climate Change: An Overview of a Quartet of Simultaneous*

Court of Justice (ICJ) is currently considering,⁵⁰ some opinions may define obligations for states to take climate action under international law and are likely to deal directly with climate science.⁵¹ Requested advisory opinions from international tribunals, regardless of their legal focus, will confront technical evidence that underlies the internationally-recognized scientific consensus on the human-driven causes of climate change and its impacts.⁵²

1. Advisory Opinions

In late 2022, the Commission of Small Island States on Climate Change and International Law (COSIS) submitted a request for an advisory opinion to the International Tribunal of the Law of the Sea (ITLOS), in which it asked for clarification of the obligations of state parties to the United Nations Convention on the Law of the Sea (UNCLOS) with respect to preserving and protecting the marine environment from climate change impacts.⁵³ The provision authorizing the COSIS to seek an advisory opinion, under the ITLOS' jurisdiction, explicitly states that climate change is adversely affecting the ocean and impacting Small Island states.⁵⁴ Additionally, the COSIS attached to the

Requests, YOUTUBE (May 3, 2023), <https://www.youtube.com/watch?v=Fza7UAPsXLI> (discussing advisory opinions from the International Tribunal of the Law of the Sea, the Inter-American Court of Human Rights, the International Court of Justice, and the African Court of Human and Peoples' Rights).

50. *Obligations of States in Respect of Climate Change*, Order, 2023 I.C.J. No. 187, at 2 (Apr. 20), <https://www.icj-cij.org/sites/default/files/case-related/187/187-20230420-ORD-01-00-EN.pdf>.

51. See Tiffany Challe-Campiz, *Taking Climate Change to the International Court of Justice: Legal and Procedural Issues*, COLUM. L. SCH.: CLIMATE L. (Sept. 29, 2021), <https://blogs.law.columbia.edu/climatechange/2021/09/29/taking-climate-change-to-the-international-court-of-justice-legal-and-procedural-issues/> (remarking that “[w]e could see an authoritative judicial determination of the validity of the science that has been summarized by the IPCC.”).

52. See Sabin Ctr. for Climate Change L., *supra* note 49.

53. See Request for Advisory Opinion to the International Tribunal for the Law of the Sea [ITLOS] by Antigua and Barbuda and Tuvalu (Dec. 12, 2022), https://www.itlos.org/fileadmin/itlos/documents/cases/31/Request_for_Advisory_Opinion_COSIS_12.12.22.pdf [hereinafter Request for Advisory Opinion to ITLOS by Antigua and Barbuda and Tuvalu]. For overviews and discussions, see Donald R. Rothwell, *Climate Change, Small Island States, and the Law of the Sea: The ITLOS Advisory Opinion Request*, 27 AM. SOC'Y INT'L L. INSIGHTS 1 (May 12, 2023), https://www.asil.org/sites/default/files/ASIL_Insights_2023_V27_I5.pdf; Maria José Alarcon & Maria Antonia Tigre, *Navigating the Intersection of Climate Change and the Law of the Sea: Exploring the ITLOS Advisory Opinion's Substantive Content*, COLUM. L. SCH.: CLIMATE L. (Apr. 24, 2023), <https://blogs.law.columbia.edu/climatechange/2023/04/24/navigating-the-intersection-of-climate-change-and-the-law-of-the-sea-exploring-the-itlos-advisory-opinions-substantive-content/>.

54. Agreement for the Establishment of the Commission of Small Island States on Climate Change and International Law art. 2(2), Oct. 31, 2021, U.N. Reg. 56940.

request a dossier of IPCC reports and official statements by COSIS member states.⁵⁵

Because the UNCLOS is a technical convention, the ITLOS has experience navigating scientific evidence.⁵⁶ Due to its familiarity with scientific processes, the ITLOS seems particularly well equipped to assess the scientific evidence that underlies the advisory opinion requested.⁵⁷ It could therefore serve as a model for interpreting international law obligations against the scientific background of climate change, and it is, thus, an important finding for other courts to rely upon.⁵⁸

In early 2023, Chile and Colombia requested an advisory opinion from the Inter-American Court of Human Rights (IACHR).⁵⁹ The

55. *Dossier Submitted by the Commission of Small Island States on Climate Change and International Law*, ITLOS (Dec. 12, 2022), <https://www.itlos.org/en/main/cases/list-of-cases/request-for-an-advisory-opinion-submitted-by-the-commission-of-small-island-states-on-climate-change-and-international-law-request-for-advisory-opinion-submitted-to-the-tribunal/dossier-submitted-by-the-commission-of-small-island-states-on-climate-change-and-international-law/> (listing documents submitted including portions of IPCC Working Group I and II reports from AR6).

56. For example, the UNCLOS definition of “pollution of the marine environment” leverages science to determine which discharges are “likely to result in such deleterious effects as harm to living resources and marine life, [and] hazards to human health[.]” U.N. Convention on the Law of the Sea art. 1(1)(4), Dec. 10, 1982, 1833 U.N.T.S. 397 [hereinafter UNCLOS]. To determine this, the UNCLOS explicitly mentions the need to consider, *inter alia*, “the best scientific evidence available,” *id.* arts. 61, 119, or the “recognized scientific methods,” *id.* arts. 165, 204. For a discussion of cases involving the ITLOS’ handling of scientific and technical evidence, see Judge Jin-Hyun Paik, President, Int’l Tribunal for the L. of the Sea, Keynote Speech on Disputes Involving Scientific and Technical Matters and ITLOS 3-5 (Aug. 22, 2018) https://www.itlos.org/fileadmin/itlos/documents/statements_of_president/paik/Iceland_Conference_President_Keynote_Speech_Final_22August2018.pdf.

57. The precautionary principle may be one way the ITLOS showcases the delicate interplay of science and the law. This is a fundamental principle in international environmental law that requires parties to take precautionary measures to prevent serious environmental harm even when scientific evidence is uncertain or incomplete. The scope of its application is currently unclear, and it remains to be seen how the ITLOS interprets the precautionary principle regarding States’ obligations of preserving and protecting the marine environment, based on IPCC reports that include scientific uncertainties. *See* Alarcon & Tigre, *supra* note 53; *see also infra* notes 153-54 and accompanying text for a discussion of Landgericht Essen [LG] [Regional Court of Essen] Dec. 15, 2016, Aktenzeichen 2 O 285/15, 2016 [hereinafter Lliuya Trial Court Decision].

58. *Cf.* BRITISH INST. OF INT’L & COMPARATIVE L., PROMOTING CLIMATE JUSTICE THROUGH INTERNATIONAL LAW: CLIMATE LITIGATION & CLIMATE ADVISORY OPINIONS ¶¶ 6, 27 (2023), https://www.biicl.org/documents/163_event_report_climate_advisories_litigation_15_march.pdf (noting that “[ITLOS] is well-positioned to come up with an authoritative interpretation of [UNCLOS] obligations” and thus “may deliver pronouncements that the ICJ could build upon[.]”).

59. Request for Advisory Opinion on the Climate Emergency and Human Rights to the Inter-American Court of Human Rights by the Republic of Colombia and the Republic of Chile (Jan. 9, 2023), https://www.corteidh.or.cr/docs/opiniones/soc_1_2023_en.pdf [hereinafter Request for Advisory Opinion to IACHR by Colombia and Chile].

request seeks to clarify the obligations of states to respond to the climate emergency within an international human rights framework, alleging human rights violations caused by climate change.⁶⁰ This request frequently cites IPCC reports in addition to individual scientific studies.⁶¹ Here again, the “political and scientific consensus” on the climate emergency is stressed.⁶²

Perhaps most prominently, a Vanuatu-led campaign of numerous countries, many of which are disproportionately affected by climate change, is seeking clarity from the ICJ on the legal obligations of states with respect to climate change.⁶³ On March 29, 2023, the U.N. General Assembly (UNGA) adopted a resolution, without a vote, requesting an ICJ advisory opinion on states’ legal obligations.⁶⁴ The Court has initiated proceedings, setting timelines for comment submissions and responses.⁶⁵

Notably, the role of science in advisory opinions can be different from its role in contentious cases.⁶⁶ In the latter, the attempt to assign individual responsibility for climate change to countries would require proof of causation.⁶⁷ This hurdle is largely avoided in the ICJ advisory opinion request context.⁶⁸ There, the legal question is prefaced by directly acknowledging the facts of climate change, referencing IPCC reports, and expressly noting, for example, “*with utmost concern* the

60. See also Maria Antonia Tigre et al., *A Request for an Advisory Opinion at the Inter-American Court of Human Rights: Initial Reactions*, COLUM. L. SCH.: CLIMATE L. (Feb. 17, 2023), <https://blogs.law.columbia.edu/climatechange/2023/02/17/a-request-for-an-advisory-opinion-at-the-inter-american-court-of-human-rights-initial-reactions/>.

61. See generally Request for Advisory Opinion to IACHR by Colombia and Chile, *supra* note 59.

62. *Id.*

63. Vanuatu lists the core group of nations as Antigua & Barbuda, Costa Rica, Sierra Leone, Angola, Germany, Mozambique, Liechtenstein, Samoa, Federated States of Micronesia, Bangladesh, Morocco, Singapore, Uganda, New Zealand, Vietnam, Romania and Portugal. *The Republic of Vanuatu is Leading the Initiative at the UN International Court of Justice for an Advisory Opinion on the Obligations of States Relevant to Climate Action*, VANUATU ICJ INITIATIVE, <https://www.vanuatuicj.com/> (last visited July 7, 2023).

64. G.A. Res. 77/276, at 3 (Mar. 29, 2023).

65. See Obligations of States in Respect of Climate Change, *supra* note 50, at 2 (fixing Oct. 20, 2023, as the date for submission of written statements on the presented questions, and Jan. 22, 2024, as the deadline for responses to those comments).

66. Contentious jurisdiction is exercised over legal disputes between two or more States. It entails certain procedural hurdles and applicability limitations and can only be exercised over States that have accepted jurisdiction of the ICJ in these cases, which the world’s largest emitters of GHG, China and the United States, have not. See Challe-Campiz, *supra* note 51.

67. *Id.*

68. *Id.*

scientific consensus . . . that anthropogenic emissions of greenhouse gases are unequivocally the dominant cause of the global warming.”⁶⁹

How might scientific evidence come before ICJ judges? The admission of scientific experts to testify directly before the ICJ and to be cross-examined by the parties is historically rare. The ICJ first allowed this in the 2014 Japanese whaling case.⁷⁰ In the request for an advisory opinion, however, none of the state representatives doubted climate change or downplayed the importance of addressing climate issues, so scientific matters were uncontested.⁷¹ If states were to substantially question the foundations of climate science and climate change, or if the ICJ itself considered anthropogenic climate change not to be a universal consensus, then scholars anticipate that scientific experts might have the opportunity to testify before the Court.⁷² In addition, if more specific questions related to attribution science and responsibility were posed, it is possible that this would elicit science-based testimony.

2. Climate Science Informs International Criminal Court Communication

In addition to these advisory opinions, AllRise—a litigation-focused non-profit—filed a communication on October 12, 2021, calling for investigation and prosecution by the International Criminal Court (ICC) for alleged crimes against humanity committed by former Brazilian President Jair Bolsonaro and members of his Administration.⁷³ The communication includes two interrelated allegations. First, it alleged that President Bolsonaro and his Administration have “knowingly facilitated and promoted” widespread attacks upon the Amazon Biome and “those

69. G.A. Res. 77/276, *supra* note 64, at 2 (emphasis in original).

70. *See generally* Whaling in the Antarctic (Austl. v. Japan: N.Z. Intervening), Judgment, 2014 I. C.J. Rep. 226 (Mar. 31); *see also* Challe-Campiz, *supra* note 51.

71. *See* Press Release, General Assembly, General Assembly Adopts Resolution Requesting International Court of Justice Provide Advisory Opinion on States’ Obligations Concerning Climate Change, U.N. Press Release GA/12497 (Mar. 29, 2023).

72. Maria Antonia Tigre & Jorge Alejandro Carrillo Banuelos, *The ICJ’s Advisory Opinion on Climate Change: What Happens Now?*, COLUM. L. SCH.: CLIMATE L. (Mar. 29, 2023), <https://blogs.law.columbia.edu/climatechange/2023/03/29/the-icjs-advisory-opinion-on-climate-change-what-happens-now/>.

73. ALLRISE, COMMUNICATION UNDER ARTICLE 15 OF THE ROME STATUTE OF THE INTERNATIONAL CRIMINAL COURT (2021), https://climatecasechart.com/wp-content/uploads/non-us-case-documents/2021/20211012_14633_na.pdf. Before this filing, activist groups had framed Bolsonaro’s acts as “ecocide,” according to the definition worked out by the Stop Ecocide Foundation. *See, e.g.*, Ernesto Londoño, *Imagine Jair Bolsonaro Standing Trial for Ecocide at the Hague*, N.Y. TIMES (Sept. 21, 2019), <https://www.nytimes.com/2019/09/21/sunday-review/bolsonaro-amazon-fire.html>; *see also* Robinson, *supra* note 49.

who defend and depend on it,” referred to as “Environmental Dependents and Defenders.”⁷⁴ Second, the communication claimed that Bolsonaro and his Administration have created a “clear and extant threat to humanity itself” through the Amazon’s deforestation,⁷⁵ with disastrous consequences for the global climate, which allegedly has resulted and will continue to result in loss of life and “physical and mental suffering.”⁷⁶

Notably, the communication incorporates and frequently cites a nearly 100-page expert report specifically prepared for this filing on global climate change impacts attributable to deforestation of the Amazon.⁷⁷ The report follows the steps of climate change attribution science outlined above, attributing deforestation promoted and aggravated by President Bolsonaro and his Administration to the increased emission of GHGs and the exacerbation of climate change.⁷⁸ The report attempts to provide scientific evidence to support the allegation that Bolsonaro’s deforestation practices created a long-term global impact on climate change that is not easily reversed.⁷⁹

The advisory opinion examples cited above, along with the ICJ communication, demonstrate that climate-related actions in international tribunals are increasing. Courts are being asked to articulate how climate change, and specifically climate science, fit into international law regimes and obligations, whether that is within the scope of a specific framework, such as under UNCLOS (e.g., the COSIS request), or within international law more broadly (e.g., the Vanuatu-led request). Regardless of the outcome of these cases, international tribunals will

74. ALLRISE, *supra* note 73, ¶¶ 1, 14. Even though every human being “depends” on a stable global climate and an intact Amazon rainforest, it appears by “Environmental Dependents and Defenders,” AllRise only means the local populations living in and off the Amazon and defending it locally against deforestation attempts. These local communities allegedly suffer(ed) persecution, humiliation, armed invasion, murder and other forms of inhumane acts, committed by President Bolsonaro and his Administration. *Id.* ¶ 14.

75. *Id.* ¶ 1.

76. *Id.* ¶¶ 35-39.

77. *Id.* ¶ 69 (citing RUPERT F. STUART-SMITH ET AL., GLOBAL CLIMATE CHANGE IMPACTS ATTRIBUTABLE TO DEFORESTATION DRIVEN BY THE BOLSONARO ADMINISTRATION: EXPERT REPORT FOR SUBMISSION TO THE INTERNATIONAL CRIMINAL COURT 15 (2021), https://www.smithschool.ox.ac.uk/sites/default/files/2022-03/ICC_report_final-sept-2021.pdf).

78. See RUPERT F. STUART-SMITH ET AL., GLOBAL CLIMATE CHANGE IMPACTS ATTRIBUTABLE TO DEFORESTATION DRIVEN BY THE BOLSONARO ADMINISTRATION: EXPERT REPORT FOR SUBMISSION TO THE INTERNATIONAL CRIMINAL COURT 21 (2021).

79. ALLRISE, *supra* note 73, ¶¶ 230-34, 237. Cited impacts include extreme weather events, deadly heat waves, droughts and wildfires, changes in rainfall patterns leading to floods and droughts, and sea level rise. *Id.*

assuredly continue to confront climate-related content as climate science advances and climate impacts become more severe and widespread.

B. *Climate Cases Already Involve Climate Science*

Climate science has played a central role in cases before domestic courts. Their treatment provides insight into how other courts, and particularly international tribunals, may respond to climate science evidence. This section highlights a few notable examples from the United States, the Netherlands, and Germany.

1. United States

In the United States, judges in state and federal courts—including the U.S. Supreme Court—have ruled on cases related to climate change.⁸⁰ Climate change has also figured prominently in the filings of high-profile rights-based cases brought on behalf of youth plaintiffs by the non-profit Our Children’s Trust (OCT).⁸¹ Climate science was front and center in *Massachusetts v. EPA*, where the U.S. Supreme Court examined a challenge by the Commonwealth of Massachusetts against the U.S. Environmental Protection Agency (EPA) for denying a petition to regulate GHG emissions from new motor vehicles.⁸² Justice John Paul Stevens, writing for the Court, found aspects of climate science critical in determining that the Commonwealth had standing to bring the case.⁸³ While the Commonwealth was given “special solicitude” because of its “stake in protecting its quasi-sovereign interests,”⁸⁴ the Court relied on declarations from climate scientists, including

80. The most common climate litigation in the United States involves claims pursuant to the National Environmental Policy Act and the Endangered Species Act. Both frequently involve climate science. See, e.g., JESSICA WENTZ, ENV’T L. INST., CLIMATE SCIENCE AND LAW FOR JUDGES: GOVERNMENT ACTION AND CLIMATE SCIENCE 7-8, 19-25 (2023).

81. See, e.g., Complaint at 3-4, *Reynolds v. State of Florida*, No. 37 2018 CA 000819 (Fla. Cir. Ct. Apr. 16, 2018); Complaint at 3-4, *Sinnok v. State of Alaska*, No. 3AN-17-09910 (Alaska Super. Ct. Oct. 27, 2017); Complaint at 2-4, *Aji P. v. State of Washington*, No. 18-2-04448-1 SEA (Wash. Super. Ct. Feb. 16, 2018); Complaint at 1-4, *Held v. Montana*, No. CDV-2020-307 (Mont. Dist. Ct. Mar. 13, 2020).

82. See *Massachusetts v. EPA*, 549 U.S. 497, 521-28 (2007).

83. See *id.* at 521-26. In U.S. federal courts, establishing Article III standing requires a plaintiff demonstrate three elements: (1) an actual or imminent injury, (2) that the injury is caused (or is “fairly traceable”) to the defendant, and (3) that a favorable decision from the court will likely redress the injury. *Id.* at 517.

84. *Id.* at 520. *But see* *United States v. Texas*, No. 22-58, slip op. at 13, n.6 (June 23, 2023) (rejecting on standing grounds a challenge brought by Texas and Louisiana against the United States related to immigration enforcement and stating that although the states relied on *Massachusetts v. EPA*, “that decision does not control this case” as it related to the denial of a

Doctors Michael MacCracken and Michael Oppenheimer and others, as well as reports from the IPCC to conclude that Massachusetts had standing.⁸⁵

When examining the injury required for standing, Justice Stevens quoted directly from Dr. MacCracken's declaration:

[Q]ualified scientific experts involved in climate change research" have reached a "strong consensus" that global warming threatens (among other things) a precipitate rise in sea levels by the end of the century, "severe and irreversible changes to natural ecosystems," a "significant reduction in water storage in winter snowpack in mountainous regions with direct and important economic consequences," and an increase in the spread of disease[.]⁸⁶

Justice Stevens called attention to two points. First, that Dr. MacCracken's declaration speaks to a field of qualified experts, and second, that the experts have reached a "strong consensus."⁸⁷ On causation, Stevens confirmed that the basic tenets of climate science were not contested in the case.⁸⁸ In response to EPA's argument that emissions were not significant enough to cause the injury, the Court found that the U.S. transportation sector accounted for more than six percent of CO₂ emissions worldwide,⁸⁹ and as such, they "make a meaningful contribution to . . . global warming."⁹⁰ Thus, accounting for GHG emissions, or showing how much emissions can be attributed

rulemaking petition, whereas *United States v. Texas* was a challenge of the Executive Branch's enforcement discretion).

85. See *Massachusetts v. EPA*, 549 U.S. at 508-11, 521-25. MacCracken was an instrumental figure in the establishment of the U.S. Global Change Research Program (USGCRP). The USGCRP was created by congressional act in 1990 and is responsible for coordinating efforts of 13 agencies to produce a quadrennial National Climate Assessment to "understand, assess, predict, and respond to human-induced and natural processes of global change." See 1 U.S. Glob. Change Rsch. Program [USGCRP], CLIMATE SCIENCE SPECIAL REPORT: FOURTH NATIONAL CLIMATE ASSESSMENT 1 (2017); see also 2 USGCRP, CLIMATE SCIENCE SPECIAL REPORT: FOURTH NATIONAL CLIMATE ASSESSMENT (2018); Global Change Research Act of 1990, § 101(b). The Fifth National Climate Assessment was released in November of 2023.

86. *Massachusetts v. EPA*, 549 U.S. at 521 (internal citations omitted).

87. *Id.*

88. See *id.* at 523 ("EPA does not dispute the existence of a causal connection between manmade greenhouse gas emissions and global warming.").

89. *Id.* at 524 (relying on declarations from another climate scientist, Michael Oppenheimer).

90. *Id.* at 525.

to a particular entity or source (i.e., source attribution), was a factor in the determination.⁹¹

Since *Massachusetts v. EPA*, plaintiffs have continued to put forward climate science evidence to advance their claims, including in cases that involve rights to a healthy and/or stable climate.⁹² Many cases allege that government policies supporting fossil fuels have violated a constitutional right to a healthy and/or stable climate.⁹³ In *Juliana v. United States*, a federal court in Oregon found that there is “no doubt that the right to a climate system capable of sustaining human life is fundamental to a free and ordered society . . . a stable climate system is quite literally the foundation ‘of society, without which there would be neither civilization nor progress.’”⁹⁴ In reaching this conclusion, however, the judge reinforced that “[t]his lawsuit is not about proving that climate change is happening or that human activity is driving it . . . those facts are undisputed.”⁹⁵ Writing at the motion to dismiss stage, and therefore taking the plaintiffs’ factual allegations as true, the opinion frequently cites to the climate science underpinning the plaintiffs’ complaint.⁹⁶ The citations include references to accounting for the amount of GHG emissions resulting from various activities, such as leasing for oil, gas, and coal production.⁹⁷

While *Juliana* has not yet seen an opinion on the merits,⁹⁸ despite two trips to the U.S. Supreme Court,⁹⁹ a divided panel of U.S. Court of

91. For other discussions of “meaningful contribution,” see *Wash. Env’t Council v. Bellon*, 732 F.3d 1131, 1145-46 (9th Cir. 2013), *reh’g en banc denied*, 741 F.3d 1075 (9th Cir. 2014) (finding that GHG emissions from Washington oil refineries, which “mak[e] up 5.9% of emissions in Washington,” are not “‘meaningful contribution’ to global GHG levels.”; see also *Amigos Bravos v. U.S. Bureau of Land Mgmt.*, 816 F. Supp. 2d 1118, 1136 (D.N.M. 2011) (“the potential 254,730 metric tons of GHGs per year that might result from the approval of 92 oil and gas leases [were] not a particularly *meaningful contribution* to global emissions.”) (emphasis added).

92. See, e.g., Complaint at 20-44, Reynolds, No. 37 2018 CA 000819; Complaint at 45-67, Sinnok, No. 3AN-17-09910; Complaint at 24-41, Aji P., No. 18-2-04448-1 SEA; Complaint at 17-26, Held, No. CDV-2020-307.

93. See 2023 *Mid-Year Review*, OUR CHILDREN’S TRUST: YOUTH V. GOV., <https://www.ourchildrenstrust.org/midyear-review-2023> (last visited June 27, 2023).

94. *Juliana v. United States*, 217 F. Supp. 3d 1224, 1250 (D. Or. 2016) (internal citation omitted).

95. *Id.* at 1234.

96. See *id.* at 1245-46.

97. See *id.* at 1246.

98. After the U.S. Court of Appeals for the Ninth Circuit dismissed the case on standing grounds, see *Juliana v. United States*, 947 F.3d 1159 (9th Cir. 2020), Judge Aiken granted plaintiff’s request to file an amended complaint, see *Juliana v. United States*, No. 6:15-CV-01517-AA, 2023 WL 3750334 (D. Or. June 1, 2023). As of this writing, the case is ongoing.

99. For a discussion of the Court’s use of the shadow docket, including in this case, see Robert V. Percial, *The Shadow Docket*, THE ENV’T FORUM (Jan./Feb. 2022); see also Richard J. Pierce, Jr.,

Appeals judges for the Ninth Circuit took notice of the role of climate science in their 2020 opinion.¹⁰⁰ Although ultimately dismissing the case under the theory that injunctive relief would not redress the plaintiffs' alleged injuries,¹⁰¹ the majority nevertheless concluded that the plaintiffs satisfied the injury and causation prongs of the standing analysis.¹⁰² On injury, the majority concluded that injuries related to domestic displacement from water scarcity and flooding provided sufficient "evidence that climate change is affecting them now in concrete ways and will continue to do so unless checked."¹⁰³ In her dissenting opinion, Judge Josephine Staton,¹⁰⁴ remarking on the important role played by climate science, concluded with an emphatic note that the "[p]laintiffs' claims are based on science, specifically, an impending point of no return."¹⁰⁵

Montana's First District Court was the first court to hold a trial on the merits and issue a decision in an OTC case.¹⁰⁶ The case involved a challenge to an exception to the Montana Environmental Policy Act (MEPA), barring state agencies from considering climate change, including for fossil fuel development.¹⁰⁷ The plaintiffs, a group of Montana youth led by Rikki Held, sought a declaratory judgment that the MEPA provision violated Montana's Constitution, which provides a right to a "clean and healthful environment."¹⁰⁸

At trial, however, it was clear that not all parties were familiar with these foundational climate science sources. For example, the director of Montana's Department of Environmental Quality suggested that, prior to trial, he was not aware of the decades of increasingly dire

The Supreme Court Should Eliminate Its Lawless Shadow Docket, 74 ADMIN. L. REV. 1 (2022) (using the U.S. Environmental Protection Agency's Clean Power Plan as an illustrative case).

100. *See* Juliana, 947 F.3d at 1166 (referencing plaintiffs' "[c]opious expert evidence" on climate change causes and impacts).

101. *See id.* at 1171 (finding that the redressability prong is not satisfied because "it is beyond the power of an Article III court to order, design, supervise, or implement the plaintiffs' requested remedial plan.").

102. *See id.* at 1168-69.

103. *Id.* at 1168.

104. *Id.* at 1160, 1164 (Judge Staton, U.S. District Judge for the Central District of California, sat by designation).

105. *Id.* at 1191.

106. *See* Held v. State of Montana, No. CDV-2020-307 (Mont. Dist. Ct. Aug. 14, 2023). As of this writing, the case is currently on appeal before the Montana Supreme Court.

107. *See id.* at 15-17.

108. *See id.* at 1-2. The Montana Constitution provides that "[a]ll persons are born free and have certain inalienable rights. They include the right to a clean and healthful environment[.]" MONT. CONST., art. II, § 3. And that "[t]he state and each person shall maintain and improve a clean and healthful environment in Montana for present and future generations." *Id.*, art. IX, § 1.

reports from the IPCC.¹⁰⁹ Moreover, one of Montana’s attorneys, in cross-examining paleoclimatologist Dr. Cathy Whitlock, mischaracterized the IPCC, referring to the intergovernmental body as the “ICP” and became seemingly confused with respect to the various acronyms involved in the IPCC reports.¹¹⁰

On August 11, 2023, Judge Seeley issued an opinion that included fact-finding statements replete with references to climate science from the plaintiff’s experts,¹¹¹ including Dr. Steven Running, Dr. Cathy Whitlock, and Peter Erickson, among others.¹¹² These experts presented testimony based on various reports, including those from the IPCC and Montana’s state climate assessment.¹¹³ Judge Seeley concluded that Montanans are experiencing the impacts of climate change,¹¹⁴ and those impacts are projected to worsen “if the State continues ignoring GHG emissions and climate change[,]”¹¹⁵ and Montana’s emissions are contributing to increases in GHG emissions worldwide.¹¹⁶ The Court found that testimony from Dr. Terry Anderson, the defendants’ expert economist, “was not well-supported, contained errors, and was not given weight by the Court.”¹¹⁷

2. The Netherlands

Two other well-known domestic climate cases are *Urgenda Foundation v. State of the Netherlands* and *Milieudefensie v. Royal Dutch Shell plc*, which are both from the Netherlands and rely on climate science related to ongoing and projected sea-level rise and other climate impacts

109. Lesley Clark, *5 Takeaways From Historic Montana Climate Trial*, CLIMATEWIRE (June 23, 2023), <https://subscriber.politicopro.com/article/eenews/2023/06/23/5-takeaways-from-montanas-historic-climate-trial-00103130>.

110. *Id.* (reporting that the attorney for Montana “[t]here’s a lot of C’s and P’s involved in this” when discussing shared socioeconomic pathways, or SSPs, and representative concentration pathways, or RCPs).

111. *Held*, No. CDV-2020-307 at 19, 23-25, 35, 38 (“There is overwhelming scientific consensus that Earth is warming as a direct result of human GHG emissions, primarily from the burning of fossil fuels.”).

112. *Id.* at 17-19; for the list of the experts and the summary of their arguments, see Jarryd Page, *Climate Science on the Docket: How Held v. Montana is Bridging Science and Law*, ENV’T L. INST.: Vibrant Env’t Blog (Aug. 11, 2023), <https://www.eli.org/vibrant-environment-blog/climate-science-docket-how-held-v-montana-bridging-science-and-law>.

113. *See Held*, No. CDV-2020-307 at 17-19.

114. *See id.* at 35-46.

115. *Id.* at 46.

116. *Id.* at 70 (“What happens in Montana has a real impact on fossil fuel energy systems, CO₂ emissions, and global warming.”).

117. *Id.* at 66.

findings.¹¹⁸ In *Urgenda*, the challengers—Dutch citizens and a Dutch environmental group—sought to advance climate action by the Dutch government.¹¹⁹ In 2018, the Dutch Appellate Court agreed with the lower court, finding the Dutch government was not doing enough to address climate change and ordering (in a global first) the government to reduce emissions to twenty-five percent below 1990 levels by 2020.¹²⁰ In reaching this conclusion, the Court referred to the fourth and fifth IPCC assessment reports extensively, cited NASA data on historical warming, and noted projections of emissions from the European Database for Global Atmospheric Research.¹²¹ The decision was affirmed by the Dutch Supreme Court.¹²²

Similarly, in *Milieudefensie*, the Court found that Royal Dutch Shell (Shell) was not doing enough to reduce emissions in light of the Paris Agreement and scientific consensus about climate change and its impacts, thus violating the duty of care under Dutch law, and ordered the corporation to reduce emissions to forty-five percent below 2019 levels by 2030.¹²³ This first-ever decision by a judge to require a private company to reduce emissions also relied on findings from IPCC reports¹²⁴ and analysis of legal protections, as articulated in *Urgenda*.¹²⁵

Climate science provided crucial support for the decision, as the *Milieudefensie* opinion cited IPCC's Fifth Assessment Report (AR5) and the 1.5°C Special Report, material from the Royal Netherlands Meteorological Institute and the International Energy Agency, reports from the European Environment Agency, as well as studies from

118. Hof's-Gravenhage 9 oktober 2018, AB 2018, 417 m.nt. GA van der Veen, Ch.W. Backes (Staat der Nederlanden/Stichting) (Neth.) [hereinafter *Urgenda* Court of Appeal Opinion]; Hof's-Gravenhage May 26, 2021, JOR 2021/208 m.nt. Biesmans, SJM (Vereeniging Milieudefensie/Royal Dutch Shell PLC) (Neth.) [hereinafter *Milieudefensie*].

119. For a brief description of the case, see *Urgenda Foundation v. State of the Netherlands*, SABIN CTR. FOR CLIMATE CHANGE L., <https://climatecasechart.com/non-us-case/urgenda-foundation-v-kingdom-of-the-netherlands/> (last visited Aug. 18, 2023).

120. *Id.*

121. See *Urgenda* Court of Appeal Opinion, *supra* note 118, ¶¶ 12, 44.

122. HR Dec. 20, 2019, JM 2020/33 m.nt. Douma, W.Th. (De Staat Der Nederlanden/Stichting Urgenda).

123. *Milieudefensie*, JOR 2021/208, ¶ 3.1.1; see Stanley Reed & Claire Moses, *A Dutch Court Rules That Shell Must Step Up Its Climate Change Efforts*, N.Y. TIMES (updated Oct. 28, 2021), <https://www.nytimes.com/2021/05/26/business/royal-dutch-shell-climate-change.html>. The case is currently on appeal in Dutch court.

124. *Milieudefensie*, JOR 2021/208, ¶ 2.3.5 (“[t]he global consequences of climate change are apparent from the reports of the Intergovernmental Panel on Climate Change”).

125. *Id.* ¶ 4.4.10 (“It can be deduced from the *Urgenda* judgment that Articles 2 and 8 of the [European Convention on Human Rights] provide protection against the consequences of dangerous climate change as a result of global warming due to Co2 emissions”).

Deltares, a Dutch research non-profit organization, on the impacts of accelerated sea-level rise on the Dutch Delta Programme and tidal basins.¹²⁶ Shell challenged the plaintiff’s characterization of some aspects of climate science, arguing that the plaintiff Milieudéfense misrepresented the scientific sources as they relate to “tipping points,” elements of the climate system that are hard to reverse upon reaching some threshold,¹²⁷ in addition to mitigation and adaptation.¹²⁸ Shell also argued that the impacts of “heat stress” and sea-level rise on the Dutch people were misrepresented.¹²⁹ Notably, however, the authority of the IPCC and the integrity of its climate science was not a centrally contested issue.¹³⁰ Shell’s contribution to climate change through its GHG emissions was similarly not in dispute.¹³¹ That this aspect went unchallenged is perhaps not surprising given Shell’s historical and global position in the energy market; though, questions of source attribution may arise for corporations that do not have the same quantity of historical and/or annual emissions. In fact, this was a point of contention in *Lliuya v. RWE AG*, discussed below.

3. Germany

Under German jurisdiction, courts have been called to help mitigate climate change or deal with its consequences. In 2021, youth plaintiffs in *Neubauer v. Germany* received a major victory before Germany’s highest court, the Federal Constitutional Court.¹³² The Higher Regional

126. See *id.* ¶¶ 2.3.5-2.3.9. The Delta Programme develops “plans to protect the country from flooding, mitigate the impact of extreme weather events, and secure supplies of freshwater.” *Delta Programme: Flood Safety, Freshwater, and Spatial Adaptation*, GOV’T OF THE NETH., <https://www.government.nl/topics/delta-programme/delta-programme-flood-safety-freshwater-and-spatial-adaptation> (last visited July 13, 2023).

127. Pleading Notes: Science, Milieudéfense et al. v. Royal Dutch Shell PLC, Case No. C/09/571932 19/379 6-16 (Hof’s-Gravenhage), ¶¶ 16-17.

128. See *id.* ¶¶ 26-27.

129. See *id.* ¶¶ 32-40.

130. *Id.* ¶ 11 (remarking that “[t]he IPCC Assessment Reports are of particular importance” and focusing on how Milieudéfense characterized the science, not on the IPCC’s credibility or output, which is described by Shell as having been “drafted very extensively and with the utmost care and precision.”).

131. Milieudéfense, JOR 2021/208, ¶ 4.4.5. (stating that “[i]t is not in dispute that these global CO2 emissions of the Shell group (Scope 1 through to 3) in the Netherlands and the Wadden area contribute to [global] warming and climate change.”).

132. See generally BVerfG, Order of the First Senate of 24 March 2021, 1 BvR 2656/18, https://www.bundesverfassungsgericht.de/SharedDocs/Entscheidungen/EN/2021/03/rs20210324_1bvr265618en.html [hereinafter *Neubauer*].

Court of Hamm is currently collecting scientific evidence in *Lliuya*, a tort case against Europe's largest single emitter of GHGs.¹³³

In *Neubauer*, the Court unanimously decided that the Federal Climate Change Act, the country's framework climate legislation that included a GHG emissions reduction mandate, was not strict enough to adequately protect the complainants' fundamental rights as articulated in Germany's Constitution.¹³⁴ Because the state has a duty to protect these rights over time, the Court ruled that the German legislature must provide a clear pathway to reduce the country's CO₂ emissions more rapidly.¹³⁵

The Court dedicated significant space to explaining the greenhouse effect, its relationship to climate change, and various climate protection measures.¹³⁶ Like other cases, it relied heavily on IPCC reports, which the opinion describes as reliable sources of current scientific knowledge on climate change. A portion of the opinion is devoted to explaining the IPCC, its history, mandate, and the multi-step process for establishing its virtually worldwide scientific consensus.¹³⁷ The Court also referenced reports by German executive agencies.¹³⁸ These sources

133. See *Luciano Lliuya v. RWE AG*, CLIMATE CHANGE LITIGATION DATABASES, <https://climatecasechart.com/non-us-case/liiuya-v-rwe-ag/#:~:text=The%20court%20noted%20that%20it,relationship%20between%20particular%20greenhouse%20gas>, for the court docket. A counterexample is a case filed by organic farmers and Greenpeace in the Administrative Court of Berlin against the Federal government for not complying with its own climate protection goal. The court dismissed the case because the plaintiffs failed to provide scientific evidence to prove standing. See Administrative Court of Berlin, Judgment of the 10. Chamber of October 31, 2019, filed under 10 K 412.18 (finding that an emissions reduction of 32% below 1990 levels instead of the envisioned 40% by 2020 did not suffice to threaten plaintiffs' fundamental rights to property, life, and profession imminently); see also Markus Sehl, *Bio-Bauern Scheitern Mit "Klimaklage"*, LEGAL TRIB. ONLINE (Oct. 31, 2019), <https://www.lto.de/recht/hintergruende/h/vg-berlin-10-k-412-18-klima-klage-umweltschutz-bauern-greenpeace-bundesregierung/>.

134. See *Neubauer*, BvR 2656/18, ¶ 117. Germany's Constitution is referred to domestically as the Basic Law (Grundgesetz). Interestingly, and unusually, the court did not put an emphasis on which fundamental right was violated, but rather took all fundamental freedoms together. See *id.* ¶¶ 142, 183.

135. See *id.* at headnote 5.

136. See *id.* ¶¶ 16-31.

137. That process requires contributing scientists to first reach an agreement before their findings can be reviewed by independent external experts; only then can they be adopted by policymakers of the member states (whose changes to the reports in turn are controlled again by the scientists). See *id.* ¶¶ 16-17 (citing to IPCC, *Guidance Note for Lead Authors of the IPCC Fifth Assessment Report on Consistent Treatment of Uncertainties* (2010); IPCC, *Procedures for the Preparation, Review, Acceptance, Adoption, Approval and Publication of IPCC reports* (2013)); see also *Preparing Reports*, IPCC, <https://www.ipcc.ch/about/preparingreports/> (last visited July 14, 2023).

138. These include the Federal Ministry for the Environment, Natural Conservation and Nuclear Safety, the German Environment Agency, the German Advisory Council on the

were used, *inter alia*, to prove that Germany is historically responsible for 4.6% of all anthropogenic GHG emissions (or currently two percent annually), and that Germany's per-capita GHG emissions exceed the global median by 100%.¹³⁹

Because of the almost-linear correlation between the increase in atmospheric CO₂ concentration and global warming, the Court explained, a specific GHG reduction obligation can be derived from the Paris Agreement's temperature target.¹⁴⁰ Still, due to the complexity of the climate system, uncertainties regarding the remaining CO₂ budget persist.¹⁴¹ The Court addressed these uncertainties explicitly, noting that scientific uncertainties cannot justify legislative arbitrariness in setting CO₂ emissions reduction goals.¹⁴² The lack of otherwise available, reliable scientific data, and the fact that the IPCC's calculations still provide the best estimate of the remaining CO₂ budget, forced the legislature to respond to indicators of irreversible damage.¹⁴³ The Court moreover cited Article 3 of the U.N. Framework Convention on Climate Change,¹⁴⁴ which provides that "[w]here there are threats of serious or irreversible damage, lack of full scientific certainty should not be used as a reason for postponing [precautionary] measures."¹⁴⁵

In *Lliuya*, attribution science is at the core of the dispute.¹⁴⁶ The plaintiff, Saúl Luciano Lliuya, a Peruvian mountain guide and farmer, sued Europe's largest individual emitter of GHGs and one of Germany's

Environment (SRU), and the German Meteorological Service, among others. *Neubauer*, BvR 2656/18, ¶ 16.

139. *See id.* ¶¶ 29-30.

140. *See id.* ¶¶ 216 et seq.

141. The IPCC and the SRU have indicated that specific correlations between cumulated emissions and global warming cannot be fully verified. *See id.* ¶¶ 222, 224-27.

142. *See id.* ¶ 220.

143. *See id.* ¶ 223. Regarding the SRU, the Court finds that it has determined the remaining CO₂ budget for Germany "using verifiable figures and sound calculation methods [and] based on the IPCC's scientifically justified assumptions[.]" *See id.* ¶ 220 (internal citation omitted) (non-authoritative translation provided by the Court itself). Therefore, it can be relied upon.

144. *See id.* ¶ 229.

145. United Nations Framework Convention on Climate Change art. 3(3), May 9, 1992, S. Treaty Doc. No. 120-38, 1771 U.N.T.S. 107 (noting that this approach should be "taking into account that policies and measures to deal with climate change should be cost-effective so as to ensure global benefits at the lowest possible cost.").

146. *See Luciano Lliuya v. RWE AG*, *supra* note 133. According to the plaintiff and his campaign support groups, this is the first case worldwide to enforce corporate liability for climate change that entered the evidentiary stage. *See Legal: A Precedent-Setting Case*, THE CLIMATE CASE: SAUL V. RWE, <https://rwe.climatecase.org/en/legal> (last visited July 14, 2023).

biggest utility companies, RWE AG.¹⁴⁷ Lliuya argued, using a 2021 study led by Dr. Rupert Stuart-Smith, that the emissions from RWE facilities are contributing to climate change and melting a glacier located near the plaintiff's property.¹⁴⁸ Lliuya further argued that glacial melt caused an increase in an adjacent glacial lake's water volume, which threatens to burst the dams and cause damage to his property.¹⁴⁹ As a remedy, Lliuya sought money damages sufficient to install protective measures against an imminent glacial lake outburst flood (GLOF).¹⁵⁰ The claim amounts to 0.47% of the cost of these adaptive measures (17,000€), a number taken directly from the 0.47% of global emissions for which RWE was allegedly responsible.¹⁵¹

At trial, the plaintiff introduced several scientific studies and expert witnesses to prove that climate change and the melting glacier threatening the plaintiff's property were caused partly by RWE's emissions.¹⁵² The Court dismissed the claim, finding that scientific causation does not amount to legal causation under German law.¹⁵³ According to the Court, even though the scientific evidence shows that all GHG emissions contribute to climate change, individual emissions could not be attributed to a single source because of the plethora of different sources.¹⁵⁴

147. *Peruvian Farmer Sues German Utility RWE over Dangers Related to Glacial Melting*, THE CLIMATE CASE: SAUL V. RWE, <https://rwe.climatecase.org/en/presse/article/peruvian-farmer-sues-german-utility-rwe-over-dangers-related-glacial-melting> (last visited Oct. 25, 2023).

148. *Id.* One 2021 study found that "it is virtually certain (>99% probability) that the retreat of Palcaraju glacier to the present day cannot be explained by natural variability alone . . . central estimate is that the overall retreat is entirely attributable to the observed temperature trend, and that the resulting change in the geometry of the lake and valley has substantially increased the outburst flood hazard." Rupert F. Stuart-Smith et al., *Increased Outburst Flood Hazard From Lake Palcacocha Due to Human-Induced Glacier Retreat*, 14 NATURE GEOSCIENCE 85, 85 (2021).

149. *Peruvian Farmer Sues German Utility RWE over Dangers Related to Glacial Melting*, *supra* note 147.

150. See Sarah Kaplan, *A Melting Glacier, An Imperiled City and One Farmer's Fight for Climate Justice*, WASH. POST (Aug. 28, 2022), <https://www.washingtonpost.com/climate-environment/interactive/2022/peru-climate-lawsuit-melting-glacier/> (discussing the Palcacocha drainage project).

151. See *id.* ("The lawsuit asked the firm to pay roughly \$20,000, about 0.47[%] of the cost of the Palcacocha drainage project - commensurate with the company's contribution to global emissions.").

152. See Lliuya Trial Court Decision, *supra* note 57 (noting the testimony of Dr. Huggel, who testified as to the portion of anthropogenic climate change that has likely caused the melting of the glaciers, and Professor Latif, whose testimony elaborated on how all GHGs contribute to glacial meltdown).

153. See Landgericht Essen [LG] [Regional Court of Essen] Dec. 15, 2016, Aktenzeichen 2 O 285/15 6-7, 2016.

154. See *id.*

On appeal, the Higher Regional Court of Hamm disagreed and found that emitters can be held responsible for damages caused by climate change.¹⁵⁵ Because the parties disagreed about the facts and were both able to substantiate their allegations with scientific proof,¹⁵⁶ the Court decided to collect evidence on the facts presented by the plaintiff, including on (1) the imminent threat of a GLOF to the plaintiff's property, and (2) the causal chain leading from RWE's emissions to global warming and the melting of the glacier.¹⁵⁷ To answer the first question, two court-appointed experts,¹⁵⁸ together with the judges and the parties, visited the site in Peru in May 2022.¹⁵⁹ Once the Court resolves the question of whether the glacial melt is an imminent threat, it will proceed to analyze the cause of that threat.

155. Oberlandesgericht Hamm [OLG] [Higher Regional Court of Hamm] Nov. 30, 2017, Aktenzeichen I-5 U 15/17 [hereinafter Lliuya 2017 November Order].

156. The reliability of the proof offered by the parties varies. The court clearly distinguishes between the scientific sources presented, valuing work prepared by experts independently from the proceedings or parties more highly than work that was commissioned by the parties. *See* Lliuya 2017 November Order, *supra* note 155. For example, a 2021 study that precisely analyzed the threat of a GLOF to the city of Huaraz was considered very valuable because it had not been commissioned by the plaintiff. *See id.* On the other hand, a study submitted by RWE was allegedly indirectly funded by RWE, as was the satellite imagery that was used in preparing the study, giving rise to doubts as to the study's authors' independence and impartiality. *See id.*; *see also* 'Battle of Science' Rages Over Peru Glacier, SOURCE MATERIAL (June 3, 2022), <https://www.source-material.org/battle-of-science-rages-over-peru-glacier/>.

157. *See* Lliuya 2017 November Order, *supra* note 155. The second question was further divided into: a) the rise of RWE's CO₂-emissions into the atmosphere, where they accumulate to higher concentration of greenhouse gases, b) the higher concentration of greenhouse gas molecules in the atmosphere, which reduces the earth's heat radiation and thus, leads to global warming, c) because of local increases in the median temperature, the melting of the Palcaraju glacier is accelerated, and the water volume of the Palcacocha lagoon is increasing to an extent that cannot be held back by natural moraines, and d) RWE's contribution to the causal chain of a)-c) is measurable and amounts to 0.47% until today (or a percentage to be determined by the expert). *See id.*

158. Dr. Rolf Katzenbach, professor at Technical University of Darmstadt, Germany, and Dr. Johannes Hübl, professor at University of Natural Resources and Life Sciences, Vienna, Austria. *See* Oberlandesgericht Hamm: Beweisaufnahme in Peru im Rechtsstreit Lliuya ./. RWE (June 17, 2022), https://www.olg-hamm.nrw.de/behoerde/presse/pressemitteilung_archiv/archiv/2022_Pressearchiv/19_22_PE_Beweisaufnahme-in-Peru-im-Rechtsstreit-Lliuya-__-RWE/index.php.

159. *See id.* The submission of the expert report is expected in summer 2023. The plaintiff, meanwhile, has moved to limit the second evidentiary questions to determining RWE's contribution to climate change, arguing that no serious doubt remains that GHG emissions cause and exacerbate global (and local) warming. *See* Brief filed by plaintiffs on April 15, 2021, to the Oberlandesgericht Hamm, Aktenzeichen I-5 U 15/17, at 19.

The Court emphasized that it was closely following the scientific discussion to the extent possible¹⁶⁰ without having the appropriate expertise, but the evidentiary questions were not sufficiently answered in accordance with the rules of a forensic procedure and German civil procedure laws.¹⁶¹ The Court acknowledged that “a certain probability” exists for the plaintiff’s assertions that RWE’s GHG emissions are partly responsible for global warming.¹⁶² However, the Court noted that RWE’s contribution to the melting of the specific glacier was “entirely unclear.”¹⁶³ As such, the 2021 Stuart-Smith study that linked retreat of the Palcaraju glacier to human activity was not considered sufficient evidence.¹⁶⁴

Regarding foreseeability or predictability, both elements of the legal standard of causation, the Court found that global warming has been a foreseeable consequence of GHG emissions ever since Dr. Charles D. Keeling began documenting atmospheric CO₂ concentrations in 1958, subsequently relating the increased concentrations to the greenhouse effect.¹⁶⁵ The year 1958 thus marked the starting point for evaluating RWE’s contribution to climate change, because only since then could RWE have known about the consequences of its actions.¹⁶⁶

160. See Lliuya 2017 November Order, *supra* note 155 (citing to the study relating to retreat of the Palcaraju glacier).

161. See Oberlandesgericht Hamm [OLG] [Higher Regional Court of Hamm] July 1, 2021, Aktenzeichen I-5 U 15/17 [hereinafter Higher Regional Court of Hamm July 1, 2021].

162. *See id.* § I.

163. *Id.* (“völlig ungeklärt”).

164. *See id.* Arguably, considering that the highest judicial authority in Germany, the Federal Constitutional Court, had articulated the scientific foundation of climate change in *Neubauer*, see generally *Neubauer*, *supra* note 132, the Higher Regional Court of Hamm could rely, in part, on those findings.

165. *See* Higher Regional Court of Hamm July 1, 2021, *supra* note 161, § II.4. Interestingly, the court considers this to be a fact known to the court which therefore does not require proof by the parties. *See id.* Yet, the court’s conclusion is interesting, considering that Keeling only started his measurements and data collection on CO₂ concentrations in 1958 but did not reach the conclusion of anthropogenic greenhouse effect until later. *See* Weart, *supra* note 12 (“Painstaking measurements by C.D. Keeling drove home the point in 1960, showing that the level of the gas was in fact rising, year by year.”). Having found that global warming as a consequence of GHG emissions has been foreseeable since 1958 does not spare the plaintiff from proving that precisely 0.47% of climate change is caused by the defendant.

166. Oberlandesgericht Hamm [OLG] [Higher Regional Court of Hamm] Sept. 27, 2021, Aktenzeichen I-31 U 46/21. RWE’s liability will depend on further elements of attribution of the causal chain to acts by RWE and its legal predecessor. *See id.* The court is considering RWE’s subsidiaries whose activities are initiated and controlled by RWE AG, and whose economic gain is realized by RWE AG. *See id.*

As these cases across a number of jurisdictions demonstrate, there is a developing theme of courts recognizing IPCC reports as the global scientific consensus on climate change. Importantly, the recognition of the IPCC as the world's authoritative source of climate science can help reduce chances of climate denial where climate change has become a divisive social and political issue.¹⁶⁷ It can also facilitate faster court proceedings when scientific findings are largely undisputed (e.g., *Juliana* and *Milieudefensie*). Further, uncertainties around particular topics addressed in IPCC reports do not reduce the value that scientific consensus has in climate litigation (e.g., *Neubauer*). Yet, other cases reveal that the attribution of certain impacts or events can still pose a serious challenge to pro-climate parties, requiring years of collecting evidence and preparing scientific reports (e.g., *Lliuya*). It is therefore important that scientists are able to communicate what they know when questions arise in legal cases, and that judges understand the language of science to appropriately assess the technical content brought before them.¹⁶⁸

IV. PREPARING THE COURTS: CLIMATE SCIENCE EDUCATION FOR JUDGES

To make informed decisions on the many and varied cases about climate change that are being brought before the world's courts, judges will require a basic understanding of climate science and an awareness of the rich landscape of scientifically reliable resources that are available to them. While this includes leveraging existing procedural tools and resources,¹⁶⁹ ongoing judicial education also plays an important role.¹⁷⁰ In some instances, judges may be able to orchestrate training

167. For a discussion of climate polarization, see generally Riley E. Dunlap et al., *The Political Divide on Climate Change: Partisan Polarization Widens in the U.S.*, 58 ENV'T: SCI. & POL'Y FOR SUSTAINABLE DEV. 4 (2016). *But see* Alec Tyson et al., *What the Data Says About Americans' Views of Climate Change*, PEW RSCH. CTR. (Aug. 9, 2023), <https://www.pewresearch.org/short-reads/2023/04/18/for-earth-day-key-facts-about-americans-views-of-climate-change-and-renewable-energy/> (detailing opinion polls that reveal consensus from Americans on the need to address climate change).

168. *See* Breyer, *supra* note 35, at 2 (stating that judicial “decisions should reflect a proper scientific and technical understanding so that the law can respond to the needs of the public.”).

169. *See, e.g.*, FED. JUDICIAL CTR. & NAT'L RSCH. COUNCIL, REFERENCE MANUAL ON SCIENTIFIC EVIDENCE, at xv (3d ed. 2011) (providing a resource that assists judges in “manag[ing] cases involving complex scientific and technical evidence” by “describ[ing] basic principles of major scientific fields from which legal evidence is typically derived and provid[ing] examples of cases in which such evidence [has been] used.”); *see also* ROBIN KUNDIS CRAIG, PROCEDURAL TECHNIQUES AVAILABLE FOR CLIMATE LITIGATION, CLIMATE SCIENCE AND LAW FOR JUDGES (2022).

170. Judicial education organizations and institutes exist in judiciaries throughout the world to help ensure judges are properly trained, are aware of the latest developments in the law, and maintain the ability to adequately adjudicate complex legal and factual disputes. Primary

sessions in connection with a specific dispute. In 2018, one famous case brought by the California cities of San Francisco and Oakland against numerous oil companies, U.S. District Judge for the Northern District of California William Alsup ordered the parties to organize a tutorial on climate science for him to learn about the issue.¹⁷¹ He even included a list of eight specific questions to guide the parties' presentations.¹⁷² While this approach to bridging the judicial and scientific knowledge gap was a good example of creative judicial decision making, Judge Alsup, and the efficiency of the legal process, would likely have benefited from education about climate science prior to a case arriving on his docket.

The Environmental Law Institute's Climate Judiciary Project (CJP) provides objective judicial-educational programming about climate science and how it is emerging in the law.¹⁷³ CJP regularly collaborates with judicial education organizations that provide broader programming, such as the National Judicial College and Federal Judicial Center. Building on the Environmental Law Institute's highly respected reputation for delivering bias-free judicial education programs, CJP works with leading scientists and legal scholars to educate judges with the basic science they need to adjudicate the climate litigation over which they preside.¹⁷⁴ CJP has developed a thirteen-module "Climate Science and Law for Judges" curriculum on important areas of climate science and related legal topics.¹⁷⁵ Operating outside the context of any specific case, the

domestic judicial educational entities are the Federal Judicial Center and the National Judicial College in the United States, the Studiecentrum Rechtspleging (Training and Study Centre for the Judiciary) in the Netherlands, and the Deutsche Richterakademie (German Judicial Academy) in Germany. European judicial educational entities include the Academy of European Law, and many entities have been consolidated in the European Judicial Training Network.

171. See Notice re Tutorial, *People of the State of California v. BP P.L.C.*, No. 17-06012 (N.D. Cal., Feb. 27, 2018), ECF No. 117. The two-part tutorial focused on "the history of scientific study of climate change" and "the best science now available on global warming, glacier melt, sea rise, and coastal flooding." *Id.*; See also Natasha Geiling, *City of Oakland v. BP: Testing the Limits of Climate Science in Climate Litigation*, 46 *ECOLOGY L.Q.* 683, 684 (2019) ("the court ordered the first-ever climate science tutorial in climate litigation[.]").

172. See Some Questions for the Tutorial, *People of the State of California v. BP P.L.C.*, No. 17-06011 (N.D. Cal., Mar. 6, 2018), ECF No. 138 (stating the questions as a follow up to the Notice re Tutorial, *supra* note 171).

173. See *About CJP*, ENV'T L. INST.: CLIMATE JUDICIARY PROJECT, <https://cjp.eli.org/about> (last visited June 29, 2023).

174. See Sandra Nichols Thiam & Paul Hanle, *Judging in a Changed Climate*, 39 *ENV'T FORUM* 54, 59 (2022).

175. See *Curriculum Summary*, ENV'T L. INST.: CLIMATE JUDICIARY PROJECT, <https://cjp.eli.org/curriculum> (last visited June 29, 2023) (science modules include topics such as How Climate Science Works, What Is Causing Climate Change?, Climate Justice, among others, while legal

effort also organizes various seminars and workshops that connect judges with climate scientists, during which judges learn from and ask questions to scientists about their areas of expertise.¹⁷⁶ Because of the high quality of the content and a growing demand for more, these educational services enjoy a wide degree of support from the judicial, scientific, and legal scholarly communities.¹⁷⁷

V. CONCLUSION

Judges in tribunals across the world are encountering cases involving climate change. As impacts become increasingly dire, and climate science continues to be refined, judges can be expected to deal with climate science in their courtrooms. Attribution science is likely to continue to play a central role. International tribunals may provide guidance on the obligations of states under numerous international law regimes, and in doing so, may consider specific climate science studies. Climate cases from domestic jurisdictions in the United States, the Netherlands, and Germany, provide examples of the role that science has played. The storm of cases is coming, and it is time to prepare.

topics include an overview and trends, government action, attribution science and tort litigation, fundamental rights, procedural techniques, and remedies).

176. See Thiam & Hanle, *supra* note 174, at 58.

177. *Id.* at 59 (noting that “[s]ince its inauguration, [CJP] ha[s] attracted the support of leading federal and state judges[.]”).