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CLIMATE CHANGE SCIENCE AND THE *DAUBERT* STANDARD

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INTRODUCTION

Climate change science attempts to predict the future based on complex modeling of potential levels of CO₂, other greenhouse gases, man-made conditions, and naturally occurring events. Even the most widely cited analysis of climate change studies expressly acknowledges the limitations on accurately predicting the effects of climate change on anything other than a macro basis.¹ These studies acknowledge substantial uncertainty in the prediction of climate change and its effects on a regional level, much less on a local level.² Recent lawsuits brought by the State of Rhode Island; the counties of King (Washington), Marin (California), and San Mateo (California); the cities of New York, San Francisco, Oakland, Santa Cruz, Imperial Beach, Richmond (California), Baltimore, and Boulder; and the Pacific Coast Federation of Fishermen's Associations against certain oil companies seek funds for anticipated localized impacts of climate change, including rising sea levels, drought, and wildfires.³ If these cases survive

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¹ Peter H. Howard & Thomas Sterner, *Few and Not So Far Between: A Meta-Analysis of Climate Damage Estimates*, 68 ENVTL. & RESOURCE ECON. 197, 198 (2017).

² See *id.* at 222–23.

³ Pac. Coast Fed'n of Fishermen's Ass'n, Inc. v. Chevron Corp., No. 3:18-cv-07477 (N.D. Cal. 2018); David Hasemyer, *Fossil Fuels on Trial: Where the Major Climate Change Lawsuits Stand Today*, INSIDE CLIMATE NEWS (July 22, 2019), <https://insideclimatenews.org/news/04042018/climate-change-fossil-fuel-company-lawsuits-timeline-exxon-children-california-cities-attorney-general> [<https://perma.cc/WQC6-6HN3>].

various justiciability challenges, plaintiffs' expert testimony supporting its claims will likely be challenged under *Daubert v. Merrell Dow Pharmaceuticals, Inc.*, the California Supreme Court's decision in *Sargon Enterprises, Inc. v. University of Southern California*, and other state court equivalents on the grounds that the science underlying plaintiffs' claims is not sufficiently reliable to be admitted into evidence.⁴ This Article explores the reasons why such plaintiffs' climate change theories and damages allegations must be carefully scrutinized under *Daubert* and *Sargon* and why the expert theories underlying plaintiffs' claims will likely be held inadmissible.

I. SCIENTIFIC EVIDENCE IS SUBJECT TO STRICT ADMISSIBILITY REQUIREMENTS

The admissibility of expert testimony, particularly scientific evidence, is often the most heavily contested issue in any particular case.⁵ Whether the case involves complex patent litigation, a murder prosecution, or allegations of far-reaching environmental harm, the outcome can often depend on the scientific experts who support a party's case.⁶

Expert testimony is critical because the jury has no other means to understand scientific evidence that is beyond the normal understanding of members of the public who have not been trained in specialized scientific methods.⁷ However, the admissibility of scientific testimony must be carefully monitored for the same reason.⁸ Jurors lack the resources to recognize errors or exaggerations in the testimony.⁹ As the Supreme

⁴ Currently thirty-nine states and the District of Columbia have adopted some version of the *Daubert* standard; California, Florida, Illinois, New York, New Jersey, Pennsylvania, Washington, and Maryland apply the *Frye* test; three states apply their own expert admissibility test. See Michael Morgenstern, *Daubert v. Frye—A State-by-State Comparison*, EXPERT INST. (Apr. 3, 2017), <https://www.theexpertinstitute.com/daubert-v-frye-a-state-by-state-comparison/> [https://perma.cc/7GHH-NHSU]. This Article is focused on federal law and those state jurisdictions that have adopted that standard or a variation thereof. *Id.*

⁵ See Janet Hoffman & Sara Weboff, *Presenting and Challenging Expert Testimony: Winning the Battle and the War*, 31 OR. ST. B. LITIG. J. 12 (2012).

⁶ Daniel Barskey, *How Designations of Expert Witnesses Can Make or Break Privilege*, ABA (May 1, 2017), <https://www.americanbar.org/groups/litigation/committees/class-actions/articles/2017/spring2017-how-designation-of-expert-witnesses-can-make-or-break-privilege/> [https://perma.cc/2KXA-DUSP].

⁷ Paul W. Grimm, *Challenges Facing Judges Regarding Expert Evidence in Criminal Cases*, 86 FORDHAM L. REV. 1601 (2018); Dani Alexis Ryskamp, *Why Are Expert Witnesses Important?*, EXPERT INST. (Dec. 20, 2018), <https://www.theexpertinstitute.com/why-are-expert-witnesses-important/> [https://perma.cc/MVP4-2HXR].

⁸ See *Daubert v. Merrell Dow Pharm., Inc.*, 509 U.S. 579, 595 (1993).

⁹ See *id.*

Court stated, “Expert evidence can be both powerful and quite misleading because of the difficulty of evaluating it.”¹⁰

A. *Courts Have Historically Been Skeptical of the Use of Expert Testimony*

Courts have long recognized that complicated cases require the guidance of experts and professionals who are able to explain scientific matters to the court and the jury.¹¹ By the late 1700s, parties had begun to retain paid experts who could support their side of the story.¹² However, the historical literature shows that almost as soon as paid experts began to testify on behalf of parties, courts and commentators expressed concern over the influence that these witnesses had over the jury.¹³ By the nineteenth century, commentators were already denouncing expert witnesses as confusing rather than helping the jury, providing contradictory testimony in areas where the jury lacked the scientific training to understand the issue at hand.¹⁴ As one lawyer wrote in 1899, the testimony of experts “is the subject of everybody’s sneer and the object of everybody’s derision. It has become a newspaper jest. The public has no confidence in expert testimony.”¹⁵ Courts during this time period repeatedly expressed similar concerns.¹⁶ As the Supreme Court stated in 1857,

¹⁰ *Id.*

¹¹ D.H. KAYE ET AL., *THE NEW WIGMORE: A TREATISE ON EVIDENCE: EXPERT EVIDENCE* 8–10 (Richard D. Friedman ed., Aspen Publishers 2018); *see also* J.M. Beattie, *Scales of Justice: Defense Counsel and the English Criminal Trial in the Eighteenth and Nineteenth Centuries*, 9 L. & HIST. REV. 221, 222, 242–44 (1991); Stephan Landsman, *A Brief Survey of the Development of the Adversary System*, 44 OHIO ST. L.J. 713, 726 (1983); Stephan Landsman, *The Rise of The Contentious Spirit, Adversary Procedure in Eighteenth Century England*, 75 CORNELL L. REV. 497 (1990).

¹² *See, e.g.*, *Folkes v. Chadd* (1782) 99 Eng. Rep. 589; *see also* TAL GOLAN, *LAWS OF MEN AND LAWS OF NATURE: THE HISTORY OF SCIENTIFIC EXPERT TESTIMONY IN ENGLAND AND AMERICA* 6, 22, 25–26, 42 (2004); Tal Golan, *Revisiting the History of Scientific Expert Testimony*, 73 BROOK. L. REV. 879 (2008).

¹³ *See Ferguson v. Hubbell*, 97 N.Y. 507, 514 (1884) (stating that expert testimony “should not be much encouraged and should be received only in cases of necessity,” because experts’ opinions “cannot fail generally to be warped by a desire to promote the cause in which they are enlisted.”); *see also* GOLAN, *supra* note 12, at 921.

¹⁴ Henry Wollman, *Physicians—Expert Witnesses, Some Reforms*, 17 MEDICO-LEGAL J. 20, 25 (1899).

¹⁵ *Id.* at 23.

¹⁶ *See, e.g.*, E.E.S. Wood, *Medical Testimony*, 7 AM. L. 92, 94 (1899) (noting that “cases

expert testimony was as “effective in producing obscurity and error as in the elucidation of truth.”¹⁷

Over a century ago, Judge Learned Hand recognized this dilemma:

The trouble with all this is that it is setting the jury to decide, where doctors disagree. The whole object of the expert is to tell the jury, not facts, as we have seen, but general truths derived from his specialized experience. But how can the jury judge between two statements each founded upon an experience confessedly foreign in kind to their own? It is just because they are incompetent for such a task that the expert is necessary at all.¹⁸

Courts realized that specialized procedures were necessary to protect the jury from the improper use of expert witnesses, who could easily mislead juries on issues far beyond their experience or prior understanding.¹⁹

B. The Development of Standards Restricting Expert Testimony

In 1923, the first effective formulation of a solution was set forth in the federal courts.²⁰ In *Frye v. United States*, the D.C. Circuit introduced the “general acceptance” test to determine the admissibility of scientific evidence.²¹ The *Frye* test provided that expert opinion based on scientific technique is admissible only where the technique is generally acceptable in the relevant scientific community.²²

condemning the value of expert witnesses and cautioning the jury against paying much attention to their opinion, are so numerous that they form an entire literature.”)

¹⁷ *McCormick v. Talcott*, 61 U.S. 402, 409 (1857); *see also* *McNally v. Colwell*, 52 N.W. 70, 73 (Mich. 1892) (“Expert evidence, while useful in many cases, is dangerous in all, and should be restricted, for the purpose of accuracy in determining the truth, which is the aim of all judicial investigation, to those cases where its use is well-nigh indispensable because of questions of science or skill being involved, in which a special and peculiar knowledge is desired in order to arrive at the truth.”); *Baxter v. Chicago R. Co.*, 80 N.W. 644, 653 (Wis. 1899) (“[S]killed witnesses come with such a bias on their minds that hardly any weight should be given to their evidence.”).

¹⁸ Learned Hand, *Historical and Practical Considerations Regarding Expert Testimony*, 15 HARV. L. REV. 40, 54–55 (1901).

¹⁹ *See, e.g.*, *Daubert v. Merrell Dow Pharm., Inc.*, 509 U.S. 579, 595 (1993); *Frye v. United States*, 293 F. 1013, 1014 (D.C. Cir. 1923).

²⁰ *See Frye*, 293 F. at 1014.

²¹ *Id.*

²² *Id.*

California (like many other states) adopted the *Frye* test.²³ In *People v. Kelly*, the California Supreme Court first laid out the traditional process for admitting expert testimony: “(1) [t]he reliability of the method must be established, usually by expert testimony, and (2) the witness furnishing such testimony must be properly qualified as an expert to give an opinion on the subject.”²⁴ “Additionally, the proponent of the evidence must demonstrate that correct scientific procedures were used in the particular case.”²⁵ In formulating the appropriate standard for determining the reliability of a new scientific technique, the court considered leaving questions of admissibility to the “discretion of the trial court,” but instead chose to follow the reasoning of the D.C. Circuit in *Frye*²⁶:

Frye, and the decisions which have followed it, rather than turning to the trial judge have assigned the task of determining reliability of the evolving technique to members of the scientific community from which the new method emerges “The requirement of general acceptance in the scientific community assures that those most qualified to assess the general validity of a scientific method will have the determinative voice.”²⁷

The court indicated that “general acceptance” could not be established by the testimony of a single witness attesting to the views of the scientific community and instead “resolution of the general acceptance issue would require consideration of the views of a typical cross-section of the scientific community, including representatives, if there are such, of those who oppose or question the new technique.”²⁸

The court in *Kelly* recognized that new advances in science are not necessarily ready for use at trial, echoing age-old concerns that juries can be improperly swayed by confusing scientific testimony.²⁹ “There has always existed a considerable lag between advances and discoveries in scientific fields and their acceptance as evidence in a court proceeding.”³⁰

²³ *People v. Kelly*, 549 P.2d 1240, 1244 (Cal. 1976).

²⁴ *Id.* (emphasis omitted) (internal citations omitted).

²⁵ *Id.* (internal submissions omitted).

²⁶ *Id.*

²⁷ *Id.* (emphasis omitted) (quoting *United States v. Addison*, 498 F.2d 741, 743–44 (1974)).

²⁸ *Id.* at 1248.

²⁹ *See Kelly*, 549 P.2d at 1245.

³⁰ *Id.* (quoting *People v. Spigno*, 319 P.2d 458, 464 (Cal. Dist. Ct. App. 1957)); *see also* *Moore v. Ashland Chem., Inc.*, 151 F.3d 269, 278–79 (5th Cir. 1998); *Braun v. Lorillard Inc.*, 84

The court mirrored the concerns expressed decades earlier by Judge Hand: “Lay jurors tend to give considerable weight to ‘scientific’ evidence when presented by ‘experts’ with impressive credentials.”³¹ The court further “acknowledged the existence of a ‘. . . misleading aura of certainty which often envelops a new scientific process, obscuring its currently experimental nature.’”³²

While the *Kelly-Frye* rule expanded the scope of the court’s inquiry into the admissibility of scientific evidence, it was also criticized as being narrowly focused on whether the methodology used by an expert was new or novel, without requiring inquiry into whether that methodology was actually reliable or trustworthy.³³

C. *A Gatekeeper Role Provides Courts with Flexibility to Guard Against Admission of Unreliable Testimony*

In 1975, Congress adopted the Federal Rules of Evidence, providing flexibility in determining whether expert testimony should be considered reliable.³⁴ Rule 702 established that expert testimony only needed to be relevant evidence that was able to “assist the trier of fact to understand the evidence or to determine a fact in issue.”³⁵

Almost twenty years after the adoption of the Federal Rules of Evidence, the U.S. Supreme Court weighed in.³⁶ It agreed that the Federal Rules of Evidence mandated a more flexible analysis than set forth under *Frye*.³⁷ Instead, the Supreme Court in *Daubert* incorporated the “general acceptance” test as one of four non-exclusive factors for evaluating the reliability of scientific evidence.³⁸ The additional factors identified were

F.3d 230, 235 (7th Cir. 1996); *Downs v. Perstorp Components, Inc.*, 126 F. Supp. 2d 1090, 1128–29 (E.D. Tenn. 1999); *Kinn v. HCR ManorCare*, 998 N.E.2d 852, 861 (Ohio Ct. App. 2013).

³¹ *Kelly*, 549 P.2d at 1245.

³² *Id.* (quoting *Huntingdon v. Crowley*, 414 P.2d 382, 390 (Cal. 1966)); see also *United States v. Addison*, 498 F.2d 741, 744 (D.C. Cir. 1974) (noting that “scientific proof may in some instances assume a posture of mystic infallibility in the eyes of a jury.”).

³³ See, e.g., *United States v. Downing*, 753 F.2d 1224, 1238 (3d Cir. 1985) (“The reliability inquiry that we envision is flexible and may turn on a number of considerations, in contrast to the process of scientific ‘nose-counting’ that would appear to be compelled by a careful reading of *Frye*.”).

³⁴ Federal Rules of Evidence, Pub. L. 93-595, Art. VII, 88 Stat. 1926, 1928, 1937–38 (1975).

³⁵ FED. R. EVID. 702 (1975) (repealed 2000).

³⁶ *Daubert v. Merrell Dow Pharm., Inc.*, 509 U.S. 579 (1993).

³⁷ *Id.* at 592, 594–95.

³⁸ *Id.* at 594.

the testability or falsifiability of the theory, the degree that the theory has been subject to peer review, and the known or potential rate of error.³⁹ In 2000, the Federal Rules of Evidence were amended to incorporate the reasoning in *Daubert*, specifically providing that evidence is admissible only if (1) “the testimony is based on sufficient facts or data,” (2) “the testimony is the product of reliable principles and methods,” and (3) “the expert has reliably applied the principles and methods to the facts of the case.”⁴⁰

In practice, *Daubert* resulted in an increase in the exclusion of expert testimony by trial courts during preliminary rulings.⁴¹ In adopting a flexible standard, combined with the Court’s admonition that trial courts must adopt “a gatekeeping role” to “screen” out unreliable testimony,⁴² *Daubert* allowed federal trial courts to resolve the deadlock that can otherwise result when dueling experts provide contradictory opinions to a lay jury that lacks the resources or means to distinguish between two opposing sets of opinions dealing with highly complex scientific theories and large amounts of data.⁴²

D. *California Trial Courts Have Analogous Standards Precluding the Admissibility of Unreliable Expert Testimony*

California law has followed a similar progression in providing trial courts with greater authority to screen out unreliable expert testimony. In *Sargon Enterprises, Inc. v. University of Southern California*, the California Supreme Court delineated the scope of a trial court’s substantial responsibility to exclude improper expert testimony.⁴³ Just as in *Daubert*, the court in *Sargon* affirmed that, under California law, trial courts have an obligation to act as a gatekeeper in screening out unreliable testimony.⁴⁴ “[U]nder Evidence Code sections 801, subdivision (b), and 802, the trial court acts as a gatekeeper to exclude expert testimony that is (1) based on matter of a type on which an expert may not reasonably

³⁹ *Id.* at 593–94.

⁴⁰ FED. R. EVID. 702.

⁴¹ See, e.g., LLOYD DIXON & BRIAN GILL, CHANGES IN THE STANDARDS FOR ADMITTING EXPERT EVIDENCE IN FEDERAL CIVIL CASES SINCE THE *DAUBERT* DECISION 41 (Rand Inst. for Civil Justice 2001), https://www.rand.org/content/dam/rand/pubs/monograph_reports/2005/MR1439.pdf [<https://perma.cc/Q8SX-6BQK>]; D. Michael Risinger, *Navigating Expert Reliability: Are Criminal Standards of Certainty Being Left on the Dock?*, 64 ALB. L. REV. 99, 104 (2000); Leah Vickers, *Daubert, Critique and Interpretation: What Empirical Studies Tell Us About the Application of Daubert*, 40 U.S.F. L. REV. 109, 143 (2005).

⁴² See FED. R. EVID. 702; *Daubert*, 509 U.S. at 589; see also Vickers, *supra* note 41, at 143.

⁴³ *Sargon Enterprises, Inc. v. Univ. of S. Cal.*, 288 P.3d 1237 (Cal. 2012).

⁴⁴ *Id.* at 1252; see *Daubert*, 509 U.S. at 589.

rely, (2) based on reasons unsupported by the material on which the expert relies, or (3) speculative.”⁴⁵ The focus of the trial court’s gatekeeping function is not on the conclusions reached by the expert but rather on the reliability of the principles and methodology applied to generate them.⁴⁶ “This means that a court may inquire into, not only the type of material on which an expert relies, but also whether that material actually supports the expert’s reasoning. ‘A court may conclude that there is simply too great an analytical gap between the data and the opinion proffered.’”⁴⁷ “In short, the gatekeeper’s role ‘is to make certain that an expert, whether basing testimony upon professional studies or personal experience, employs in the courtroom the same level of intellectual rigor that characterizes the practice of an expert in the relevant field.’”⁴⁸

In explaining the scope of the “substantial ‘gatekeeping’ responsibility” imposed on the trial courts, the court in *Sargon* emphasized the holding in *Herman Schwabe, Inc. v. United Shoe Machinery Corp.* that

[I]t is the jury system itself that requires the common law “judge, in his efforts to prevent the jury from being satisfied by matters of slight value, capable of being exaggerated by prejudice and hasty reasoning . . . to exclude matter which does not rise to a clearly sufficient degree of value”; “something more than a minimum of probative value” is required. . . . These comments are especially pertinent to an array of figures conveying a *delusive impression of exactness* in an area where a jury’s common sense is less available than usual to protect it.⁴⁹

The Court’s pronouncements in *Sargon* are part of a consistent trend in federal and California law towards imbuing trial courts with the flexibility and discretion to exclude unreliable testimony that would be misleading and deceptive to the jury.⁵⁰ Under both federal and state law, trial courts have an obligation to strictly examine scientific evidence to

⁴⁵ *Sargon*, 288 P.3d at 1252.

⁴⁶ *Id.*; see also *People v. Stamps*, 3 Cal. App. 5th 988, 994 (2016) (“[T]rial courts . . . are charged with an important gatekeeping ‘duty’ to exclude expert testimony when necessary to prevent unreliable evidence and insupportable reasoning from coming before the jury.”).

⁴⁷ *Sargon*, 288 P.3d at 1252 (internal citations omitted).

⁴⁸ *Id.* (internal citations omitted).

⁴⁹ *Id.* at 1250 (quoting *Herman Schwabe, Inc. v. United Shoe Machinery Corp.*, 297 F.2d 906, 912 (1962)) (emphasis added).

⁵⁰ See, e.g., *People v. Richardson*, 183 P.3d 1146, 1178 (Cal. 2008); *People v. Prince*, 156 P.3d 1015, 1049 n.8 (Cal. 2007) (noting the trial court’s “gatekeeping responsibility”).

ensure that the expert's testimony is "the product of reliable principles and methods."⁵¹ The mandate for this careful examination is a recognition that expert testimony, particularly on scientific issues, can be fundamentally deceptive to juries where such testimony exudes an aura of exactitude that is not supported by the underlying data.⁵² Without a meaningful process to control the admission of this testimony, juries have little ability to ascertain for themselves whether the expert opinion is based on reliable evidence.⁵³

In enforcing this obligation, courts must pay close attention to the critical difference between how scientific truth is discovered in the laboratory, and how scientific truth is sought and applied in the courtroom.⁵⁴ Simply put, the scientific process of constantly trying new hypotheses and assimilating new data is fundamentally inconsistent with a legal process that requires the efficient, conclusive and final resolution of legal controversies.⁵⁵ As the U.S. Supreme Court put it in *Daubert*, "Scientific conclusions are subject to *perpetual revision*. Law, on the other hand, must resolve disputes *finally and quickly*."⁵⁶ The *Daubert* Court specifically identified this dichotomy:

We recognize that, in practice, a gatekeeping role for the judge, no matter how flexible, inevitably on occasion will prevent the jury from learning of authentic insights and innovations. That, nevertheless, is the balance that is struck by Rules of Evidence *designed not for the exhaustive search for cosmic understanding but for the particularized resolution of legal disputes*.⁵⁷

In other words, the courtroom is not the place to adjudicate new theories or scientific uncertainties nor to ascertain the outer limits of scientific knowledge.⁵⁸ The court system is meant to resolve legal disputes in an efficient, comprehensive and final manner. The courtroom is no place for expert opinions that are anecdotal, in progress, not yet fully

⁵¹ FED. R. EVID. 702.

⁵² *See Sargon*, 288 P.3d at 1250.

⁵³ *See id.*

⁵⁴ *Moore v. Ashland Chem., Inc.*, 151 F.3d 269, 275 (1998).

⁵⁵ *See id.*

⁵⁶ *Daubert v. Merrell Dow Pharm., Inc.*, 509 U.S. 579, 597 (1993) (emphasis added).

⁵⁷ *Id.* (emphasis added).

⁵⁸ *Rosen v. Ciba-Geigy Corp.*, 78 F.3d 316, 319 (7th Cir. 1996); *Flores v. Allstate Tex. Lloyd's Co.*, 229 F. Supp. 2d 697, 700–04 (S.D. Tex. 2002); *Colon v. BIC USA, Inc.*, 199 F. Supp. 2d 53, 75–76 (S.D.N.Y. 2001).

formed, or are at the leading edge of new scientific theories.⁵⁹ Similarly, courts must determine whether the evidence proffered is genuinely scientific, as distinct from being unscientific speculation offered by a genuine scientist.⁶⁰

II. CLIMATE CHANGE CASES WILL NECESSARILY REQUIRE EXPERT TESTIMONY SHOWING THAT CARBON EMISSIONS CAUSED PLAINTIFFS' INJURIES

These standards apply to the increasing number of cases being filed by states, counties, municipalities, NGOs, and individuals alleging that global warming or climate change has caused or will cause them harm. Ever since the Supreme Court ruled in 2007 that greenhouse gases are “air pollutants” under the Clean Air Act, various cases have been filed seeking damages or injunctive relief on the grounds that insufficient action has been taken in response to anthropogenic (or human-caused) climate change.⁶¹ While these cases most often have been dismissed at early stages based on preemption or the political question doctrine (and affirmed on appeal),⁶² similar cases continue to be filed.⁶³

In 2017 and 2018, eight cities and counties in California, along with New York City, counties and municipalities in Colorado and Washington State, and the State of Rhode Island, brought civil lawsuits against numerous oil and gas companies, alleging that their fossil fuel production and

⁵⁹ *Rosen*, 78 F.3d at 319; *Wheat v. Pfizer, Inc.*, 31 F.3d 340, 343 (5th Cir. 1994); *Downs v. Perstorp Components, Inc.*, 126 F. Supp. 2d 1090, 1128 (E.D. Tenn. 1999). Similar holdings have also applied the *Frye* test. *Ramirez v. State*, 810 So. 2d 836, 851 (Fla. 2001); *Moore v. Harley-Davidson Motor Co. Grp.*, 241 P.3d 808, 815–16 (Wash. Ct. App. 2010).

⁶⁰ *Tamraz v. Lincoln Elec. Co.*, 620 F.3d 665, 677 (6th Cir. 2010) (citing *Rosen*, 78 F.3d at 318); *Moore v. Ashland Chem., Inc.*, 151 F.3d 269, 278–79 (5th Cir. 1998) (citing *Rosen*, 78 F.3d at 318).

⁶¹ See *Massachusetts v. EPA*, 549 U.S. 497 (2007); Hasemyer, *supra* note 3.

⁶² See, e.g., *American Elec. Power Co. v. Connecticut*, 564 U.S. 410, 415 (2011); *Native Village of Kivalina v. ExxonMobil Corp.*, 696 F.3d 849, 853 (9th Cir. 2012); *Comer v. Murphy Oil USA*, 607 F.3d 1049, 1053 (5th Cir. 2010).

⁶³ See, e.g., *City of N.Y. v. BP P.L.C.*, 325 F. Supp. 3d 466, 475 (S.D.N.Y. 2018) (holding that “[g]lobal warming and solutions thereto must be addressed by the two other branches of government.”); *City of Oakland v. BP P.L.C.*, 325 F. Supp. 3d 1017, 1026 (N.D. Cal. 2018) (holding that “questions of how to appropriately balance these worldwide negatives against the worldwide positives of the energy itself, and of how to allocate the pluses and minuses among the nations of the world, demand the expertise of our environmental agencies, our diplomats, our Executive, and at least the Senate,” and that “[n]uisance suits in various United States judicial districts regarding conduct worldwide are far less likely to solve the problem and, indeed, could interfere with reaching a worldwide consensus”).

sales contribute to increased carbon emissions, which in turn have caused global warming.⁶⁴ Similarly, in late 2018, suit was filed in state court in San Francisco by an association of fishermen alleging that climate change caused by fifteen oil companies resulted in algae blooms that harmed Dungeness crab fisheries.⁶⁵ These cases generally assert claims sounding in nuisance and occasionally negligence, alleging that companies knew that their production and sale of fossil fuels would cause global warming, rising waters, and other climate-related effects.⁶⁶ These plaintiffs claim that oil companies should pay for the local government's increased infrastructure costs incurred to combat the effects of climate change.⁶⁷

The claims brought by the cities of San Francisco and Oakland were dismissed by the U.S. District Court for the Northern District of California, and are currently pending on appeal.⁶⁸ Other climate change actions brought by other cities and counties in California have been remanded back to state court, subject to an interlocutory appeal to the Ninth Circuit.⁶⁹ Assuming that these lawsuits are allowed to proceed in California state court and are not dismissed on jurisdictional grounds, plaintiffs will be required to present admissible expert testimony to demonstrate that defendants' conduct in producing and marketing oil and gas was a substantial factor in causing their harm.⁷⁰

There have also been lawsuits brought by groups of individuals alleging that federal or certain state governments are obligated to take further action to slow or abate climate change.⁷¹ For example, in *Juliana v. United States*, several minor plaintiffs have brought claims under the public trust doctrine, demanding that the federal government cease

⁶⁴ Hasemyer, *supra* note 3.

⁶⁵ Pac. Coast Fed'n of Fishermen's Ass'ns, Inc. v. Chevron Corp., No. 3:2018cv07477 (N.D. Cal. filed Dec. 12, 2018).

⁶⁶ Complaint at ¶¶ 179–90, ¶¶ 218–39, Pac. Coast Fed'n of Fishermen's Ass'ns, Inc. v. Chevron Corp., No. 3:2018cv07477; Hasemyer, *supra* note 3.

⁶⁷ Complaint at ¶¶ 179–90, ¶¶ 218–39, Pac. Coast Fed'n of Fishermen's Ass'ns, Inc. v. Chevron Corp., No. 3:2018cv07477; Hasemyer, *supra* note 3.

⁶⁸ *City of Oakland*, 325 F. Supp. at 1028. Similarly, the lawsuit brought by the City of New York was dismissed by the U.S. District Court for the Southern District of New York and has been appealed to the Second Circuit. Plaintiff's Notice of Appeal at 1, City of N.Y. v. BP P.L.C., No. 18-2188cv (2d Cir. July 26, 2018).

⁶⁹ County of San Mateo v. Chevron Corp., 294 F. Supp. 3d 934, 939 (N.D. Cal. 2018) (granting motions to remand).

⁷⁰ *Rutherford v. Owens-Illinois, Inc.*, 941 P.2d 1203, 1214 (Cal. 1997) (“California has definitively adopted the substantial factor test [such that] . . . a cause in fact is something that is a substantial factor in bringing about the injury.”).

⁷¹ See Hasemyer, *supra* note 3.

government programs that subsidize or foster development of oil and gas resources.⁷² They allege standing based on how they have been impacted by a variety of physical phenomena, such as current and projected drought and lack of snow; ocean acidification; algal blooms; an invasion of Sargassum seaweed on local beaches; climate-induced migration of forest species; and increases in forest fires, ice storms, hurricanes, and tornadoes.⁷³ At least nine similar lawsuits have been filed in state courts from Alaska to Florida.⁷⁴

Climate change cases brought in federal or state courts require a showing that the localized impacts alleged as the basis for standing have in fact been caused by climate change. “To satisfy the causality element for Article III standing, Plaintiffs must show that the injury is causally linked or ‘fairly traceable’ to the Agencies’ alleged misconduct, and not the result of misconduct of some third party not before the Court.”⁷⁵ Courts have been quick to dismiss climate change actions where the requisite showing of causation has not been satisfied. *Washington Environmental Council v. Bellon* held that there is “a natural disjunction between Plaintiffs’ localized injuries and the greenhouse effect.”⁷⁶

In *Juliana*, the district court denied the government’s motion to dismiss on standing grounds, relying on the fact that “[a] plaintiff must support each element of the standing test ‘with the manner and degree of evidence required at the successive stages of the litigation.’”⁷⁷ Because “at the motion to dismiss stage ‘general allegations’ suffice to establish

⁷² *In re United States*, 884 F.3d 830, 833 (9th Cir. 2018) (“Twenty-one young plaintiffs brought suit against the United States, the President, and various Executive Branch officials and agencies, alleging that the defendants have contributed to climate change in violation of the plaintiffs’ constitutional rights.”).

⁷³ First Amended Complaint ¶¶ 16–90, *Juliana v. United States*, 217 F. Supp. 3d 1224 (D. Or. 2016).

⁷⁴ *State Judicial Actions Now Pending*, OUR CHILDREN’S TRUST, <https://www.ourchildrenstrust.org/pending-state-actions> [<https://perma.cc/6BGY-TVHV>] (last visited Dec. 3, 2019). *But see* *Aji P. v. State of Washington*, No. 18-2-04448-1, 2018 SEA (Wash. Super. Ct., Aug. 14, 2018) (granting motion to dismiss Washington state court action on the basis that the alleged issues are political questions that cannot be resolved by a court and must be addressed by the executive and legislative branch).

⁷⁵ *Wash. Env’tl. Council v. Bellon*, 732 F.3d 1131, 1141 (9th Cir. 2013).

⁷⁶ *Id.* at 1143–44 (“Because a multitude of independent third parties are responsible for the changes contributing to Plaintiffs’ injuries, the causal chain is too tenuous to support standing.”); *see also* *Native Village of Kivalina v. ExxonMobil Corp.*, 663 F. Supp. 2d 863, 880–81 (N.D. Cal. 2009), *aff’d*, 696 F.3d 849 (9th Cir. 2012).

⁷⁷ *Juliana v. United States*, 217 F. Supp. 3d 1224, 1242 (D. Or. 2016) (quoting *Lujan v. Defenders of Wildlife*, 504 U.S. 555, 561 (1992)), interlocutory appeal certified, 2018 U.S. Dist. LEXIS 207366, at *11–12 (D. Or. Nov. 21, 2018).

standing,”⁷⁸ the court overlooked the fact that there were only “conclusory” allegations of a “causal chain” linking the plaintiffs’ injuries with the government’s policies in favor of oil and gas production.⁷⁹ The court noted that “[e]ach link in these causal chains may be difficult to prove, but the ‘spectre of difficulty down the road does not inform [the] justiciability determination at this early stage of the proceedings.’”⁸⁰ Therefore, the district court allowed these claims to proceed past the motion to dismiss stage, although the court subsequently certified its denial of the government’s pretrial motions for interlocutory appeal to the Ninth Circuit Court of Appeals, after multiple requests for a stay and mandamus relief were filed in the higher courts.⁸¹

However, “[i]n response to a summary judgment motion . . . [a plaintiff’s claims] can no longer rest on mere allegations, but must set forth by affidavit or other admissible evidence the specific facts,” which will be taken as true for purposes of summary judgment.⁸² At the final stage, those facts, if controverted, “must be supported adequately by the evidence adduced at trial.”⁸³ So even though the plaintiffs in *Juliana* seek only injunctive and declaratory relief challenging certain governmental policies,⁸⁴ any determination about the merits of their claims will necessarily require evidence in the form of expert testimony that climate change has in fact caused plaintiffs’ alleged injuries.

Accordingly, whether lawsuits are asserted against oil companies or governmental agencies, any claims that survive jurisdictional challenges will be required to show through expert testimony a causal link between the plaintiffs’ purported injuries and resulting anthropogenic climate change. In lawsuits brought against oil companies, plaintiffs will have to present admissible evidence tying a specific defendant’s conduct to a particular consequence of climate change and showing that anthropogenic climate change will result in the claimed damage. In lawsuits

⁷⁸ *Id.* at 1242.

⁷⁹ *Id.* at 1246.

⁸⁰ *Id.* (quoting *Alperin v. Vatican Bank*, 410 F.3d 532, 539 (9th Cir. 2005)).

⁸¹ *Juliana v. United States*, No. 6:15-cv-01517-AA, 2018 U.S. Dist. LEXIS 207366, at *11–12 (D. Or. Nov. 21, 2018).

⁸² *Lujan v. Defenders of Wildlife*, 504 U.S. 555, 561 (1992) (quoting *Gladstone, Realtors v. Village of Bellwood*, 441 U.S. 91, 115 (1979)).

⁸³ *Id.*

⁸⁴ This is in contrast to the other referenced climate change cases where the plaintiffs seek damages related to the impacts of climate change and the alleged costs of responding to climate change. These cases seeking damages will present other issues beyond causation, including claims of speculative damages, etc.

demanding further government action, the plaintiffs similarly will have to present admissible evidence showing that they have standing because anthropogenic climate change has caused them the specific harm claimed or is reasonably expected to cause them harm. In either case, any final determination of these lawsuits will ultimately depend upon admissible scientific evidence attributing localized impacts to global climate change that was caused by human activity.

III. THE SPECIFIC CLAIMS REGARDING CLIMATE CHANGE

The lawsuits filed by plaintiffs alleging that oil companies' development and sale of fossil fuels has caused catastrophic climate change all allege similar types of injury or damage. Plaintiffs allege that defendants are responsible for sea level rise and associated storm surges, drought, reduced snowpack, increased wildfires, extreme temperature increases and resulting forest die-offs, crop failures, and other types of ecosystem damage.⁸⁵ For the most part, these claims are focused on the local or regional effects of climate change with plaintiffs alleging damages that have been or will be incurred to respond to the dangers caused by anthropogenic emissions of greenhouse gases.

In order to prevail, these plaintiffs will have to show that sea-level rise, drought, increased wildfires, and other climate effects resulted from the conduct of the defendant and has caused or is reasonably likely to cause the harm to them. Plaintiffs must also show that these alleged impacts of climate change are the result of anthropogenic forcings and not natural forcings or simply the natural variability of the weather. And these claims will also be required to overcome the fact that similar levels of rising temperatures and their impacts have occurred in the past that cannot be attributed to human activities.⁸⁶ Courts have dismissed climate change actions where the requisite showing of causation has not been satisfied, holding as in *Bellon* that there is "a natural disjunction between Plaintiffs' localized injuries and the greenhouse effect."⁸⁷

⁸⁵ See Complaint at ¶¶ 103–09, *City of N.Y. v. BP P.L.C.*, No. 18-cv-00182-JFK (S.D.N.Y. 2018); Complaint at ¶¶ 85–90, *People v. BP P.L.C.*, No. RG17875889 (Cal. Super. Ct. 2017); Complaint at ¶¶ 111–15, *Bd. of Comm'rs of Boulder Cty. v. Suncor Energy (USA), Inc.*, No. 2018CV30349 (Colo. D. Ct. 2018).

⁸⁶ *Wash. Env'tl. Council v. Bellon*, 732 F.3d 1131, 1141 (9th Cir. 2013).

⁸⁷ *Id.* at 1143–44 (holding that "[b]ecause a multitude of independent third parties are responsible for the changes contributing to Plaintiffs' injuries, the causal chain is too tenuous to support standing."); see also *Native Village of Kivalina v. ExxonMobil Corp.*, 663 F. Supp. 2d 863, 880–81 (N.D. Cal. 2009), *aff'd*, 696 F.3d 849 (9th Cir. 2012).

IV. THE STUDY OF CLIMATE SCIENCE

Expert testimony will play an important role in climate change cases (that survive jurisdictional challenges). Given the complexity of the issues and lack of direct evidence, expert testimony will be necessary to prove causation. For those municipalities, counties, and states that have sued individual companies based on their alleged contribution to global carbon emissions, expert testimony will be required to show that these companies have actually caused or contributed to the damages claimed by plaintiffs.

A. *The IPCC Cannot Provide a Basis for Plaintiffs' Causation Conclusions*

This Article does not examine specific opinions that have been set forth by designated experts in climate change cases. Instead, it examines whether the principles and methods that could potentially be relied upon by the expert are sufficiently reliable, and whether these principles and methods can be properly applied for the purposes for which they will be needed in the climate change cases.

With respect to climate science, plaintiffs are likely to rely on the Intergovernmental Panel on Climate Change (“IPCC”).⁸⁸ “The [IPCC] was established by the United Nations Environment Programme [“UNEP”] and the World Meteorological Organization [“WMO”] in 1988” to help establish a scientific view on the current state of knowledge in climate change and its potential environmental and socio-economic impacts.⁸⁹ In the same year, the UN General Assembly endorsed the action by WMO and UNEP in jointly establishing the IPCC.⁹⁰

The IPCC periodically publishes reports specifying the current status and limits of the international community’s understanding of climate change and its association with human activities. The IPCC published its First Assessment Report (“FAR”) in 1990, a supplementary report in 1992, a Second Assessment Report (“SAR”) in 1995, a Third Assessment

⁸⁸ An argument could be made that the IPCC reports, themselves, do not meet the standard for admissibility. However, this Article does not address that argument. This Article also does not address whether the IPCC reports are suitable for other decision-making, such as policy positions. Rather, this Article assumes that the IPCC reports will be recognized and plaintiffs will attempt to use the reports to draw further individual conclusions.

⁸⁹ *About the IPCC*, INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE, <https://www.ipcc.ch/about/history/> [<https://perma.cc/56MX-DRV9>] (last visited Dec. 3, 2019).

⁹⁰ *Id.*

Report (“TAR”) in 2001, a Fourth Assessment Report (“AR4”) in 2007 and a Fifth Assessment Report (“AR5”) in 2014.⁹¹ The IPCC is currently preparing the Sixth Assessment Report (“AR6”), which will be completed in 2022.⁹² Although the IPCC’s findings and conclusions are not universally accepted, plaintiffs are likely to put forth these reports as authoritative sources in terms of what areas are still uncertain and what areas need additional research.

In the most recently published report, AR5, the IPCC discusses the current state of climate science, and particularly the limits in which that science is competent to predict future events and attribute natural phenomena to anthropogenic climate change. Throughout AR5, the authors specify the degree of confidence for their conclusions and findings.⁹³ “A level of confidence is expressed using five qualifiers: ‘very low,’ ‘low,’ ‘medium,’ ‘high,’ and ‘very high.’”⁹⁴

⁹¹ *Id.*

⁹² *Id.*

⁹³ INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE, AR5 CLIMATE CHANGE 2014: SYNTHESIS REPORT 2 (2015), https://ar5-syr.ipcc.ch/ipcc/ipcc/resources/pdf/IPCC_SynthesisReport.pdf [<https://perma.cc/NP5W-4ZQC>] [hereinafter SYNTHESIS REPORT] (stating that key assessment findings are “based on the author teams’ evaluations of underlying scientific understanding and is expressed as a qualitative level of confidence (from very low to very high) and, when possible, probabilistically with a quantified likelihood (from exceptionally unlikely to virtually certain)”).

⁹⁴ INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE, GUIDANCE NOTE FOR LEAD AUTHORS OF THE IPCC FIFTH ASSESSMENT REPORT ON CONSISTENT TREATMENT OF UNCERTAINTIES 3 (2010), https://wg1.ipcc.ch/AR6/documents/AR5_Uncertainty_Guidance_Note.pdf [<https://perma.cc/KEU5-76ZZ>] [hereinafter GUIDANCE NOTE].

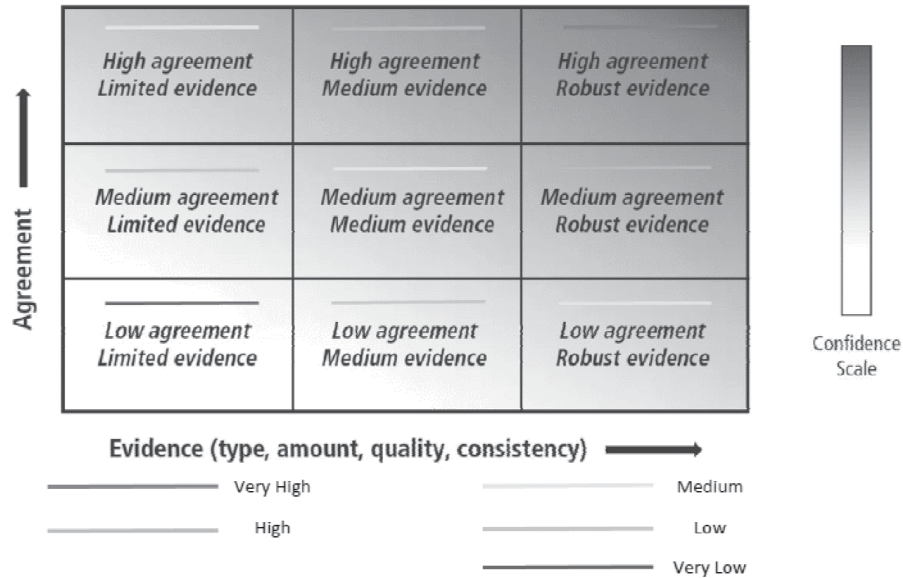


Figure 1: Confidence levels are a combination of level of agreement and evidence. There are five levels, shown with colours. (IPCC 2013)

Figure 1⁹⁵

For AR5, these confidence levels are based on a sliding scale assessment of the evidence supporting a conclusion (as either robust, medium, or limited) and the degree of scientific agreement for that conclusion (high, medium, or low).⁹⁶ Thus, a low level of confidence means that a finding is based on limited evidence or low agreement among the scientists. Models relied on by the IPCC in AR5 had a 60 percent confidence level which is a much lower confidence level than is traditionally accepted by scientists—90 to 95 percent—to establish a fact scientifically.⁹⁷ The existing uncertainty of AR5’s predictions is also established by the

⁹⁵ *Confidence and Likelihood in the IPCC Fifth Assessment Report, Fact Sheet*, AUSTRALIAN GOVERNMENT, DEPARTMENT OF THE ENVIRONMENT, <https://www.environment.gov.au/system/files/resources/b4ba2892-f126-4c4f-a47e-08ca3767eacf/files/wa-decoding-confidence-and-likelihood-ippc.pdf> [https://perma.cc/B39W-KBNJ] (last visited Dec. 3, 2019).

⁹⁶ GUIDANCE NOTE, *supra* note 94, at 3. It should be noted that this Guidance Note explains that confidence should not be interpreted probabilistically, and it is distinct from “statistical confidence.”

⁹⁷ INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE, AR5 CLIMATE CHANGE 2013: THE PHYSICAL SCIENCE BASIS 8, 36, 49 (2013), https://www.ipcc.ch/site/assets/uploads/2018/02/WG1AR5_all_final.pdf [hereinafter CLIMATE CHANGE 2013]; Liz Roth-Johnson, *Confidence Intervals: Statistical Techniques*, VISIONLEARNING (2016), <https://www.visionlearning.com/en/library/Math-in-Science/62/Confidence-Intervals/239> [https://perma.cc/46RL-QBU9].

prediction range relating to future climate warming, which projects that temperatures may increase between 4.3 degrees Fahrenheit to 11.5 degrees Fahrenheit by 2100.⁹⁸ Models which have a two in five chance of being wrong simply do not have the requisite degree of reliability to impose liability in a court of law.

Additionally, AR5 acknowledges the potential fallibility of its conclusions on all aspects of climate change and that its conclusions are subject to change “[e]ven after publication, findings are further analysed and evaluated. That is the self-correcting nature of the scientific process.”⁹⁹

Through the progression of five assessment reports, starting in 1990, the IPCC has increased its confidence level that global warming has been influenced by human activities.¹⁰⁰ The rest of the analysis and assessment laid out in AR5 makes clear that significant gaps still exist in the scientific knowledge about climate change. The IPCC reports address the potential global, regional, and local impacts of climate change.¹⁰¹ While the IPCC speaks with confidence regarding some of its findings, it also acknowledges that some of its prior predictions of the nature and extent of climate change have been overstated and proven to be erroneous.¹⁰²

B. Climate Models Make Numerous Assumptions that May Be Inaccurate or Imprecise

The study of climate science and the conclusions reached in the IPCC Reports are based primarily on the study of climate models.¹⁰³ The global climate of the Earth is extraordinarily complicated, and climate models are needed to create a virtual system that is intended to evolve in the same way as the real world. Various algorithms are used to represent the interaction of different elements of the climate system, including solar activity, the atmosphere, land surface, ocean surface, and sea ice. Over time, modeling tools became more complicated as the computing process became more powerful. As these models become more complicated, the AR5 Report recognizes that the increase in complexity necessarily results in new sources of possible error and increased uncertainty:

⁹⁸ Glen Scherer, *IPCC Predictions: Then Versus Now*, CLIMATE CENT. (Dec. 11, 2012), <https://www.climatecentral.org/news/ipcc-predictions-then-versus-now-15340> [<https://perma.cc/26U4-XJM7>].

⁹⁹ CLIMATE CHANGE 2013, *supra* note 97, at 123.

¹⁰⁰ GUIDANCE NOTE, *supra* note 94, at 5.

¹⁰¹ SYNTHESIS REPORT, *supra* note 93, at 76.

¹⁰² CLIMATE CHANGE 2013, *supra* note 97, at 43.

¹⁰³ *Id.* at 4.

Climate models of today are, in principle, better than their predecessors. However, *every bit of added complexity*, while intended to improve some aspect of simulated climate, *also introduces new sources of possible error* (e.g., via uncertain parameters) and *new interactions between model components that may, if only temporarily, degrade a model's simulation of other aspects of the climate system*. Furthermore, despite the progress that has been made, scientific uncertainty regarding the details of many processes remains.¹⁰⁴

This uncertainty is confirmed by the fact that many of the climate change conclusions presented in AR5 discuss climate change in terms of ranges of possible anthropogenic forcings or the range of potential temperature increases. For example, there is wide variation in AR5 predictions regarding the potential extent of the amount of carbon dioxide that can be expected to be present in the Earth's atmosphere, which in turn affect the potential impacts of climate change. AR5 presents four different Representative Concentration Pathways ("RCPs") for climate modeling and research, which describe different climate futures, all of which are considered possible depending on how much greenhouse gas is emitted in the years to come.¹⁰⁵ The variations are significant, with the RCP's range varying by more than three times from the low end to the high end.¹⁰⁶ The variation occurs because models require scientists to make numerous assumptions about not only anthropogenic forces but also natural forces (e.g., cloud cover, volcanic eruptions, solar radiation, etc.) that depend on the occurrence of future events, which obviously may or may not occur.¹⁰⁷

Additionally, AR5 presents three different models that project the Earth's temperature through 2050. These different models make significantly different assumptions and are widely at variance with one another.¹⁰⁸ Based on the models and the mission scenarios the range gets

¹⁰⁴ *Id.* at 824 (emphasis added).

¹⁰⁵ *Id.* at 29.

¹⁰⁶ *Id.* ("They are identified by their approximate total radiative forcing in year 2100 relative to 1750: 2.6 W m⁻² for RCP2.6, 4.5 W m⁻² for RCP4.5, 6.0 W m⁻² for RCP6.0, and 8.5 W m⁻² for RCP8.5.").

¹⁰⁷ *Id.* at 13–14.

¹⁰⁸ "The increase of global mean surface temperature by the end of the 21st century (2081–2100) relative to 1986–2005 is *likely* to be 0.3°C to 1.7°C under RCP2.6, 1.1°C to 2.6°C under RCP4.5, 1.4°C to 3.1°C under RCP6.0 and 2.6°C to 4.8°C under RCP8.5." See SYNTHESIS REPORT, *supra* note 93, at 10.

wider as it gets farther out in the future, reflecting the common sense notion that it's harder to predict things as they go into the future.¹⁰⁹

The variability and breadth of the possible outcomes should raise substantial concerns with respect to the reliability of expert opinions relating to predicted climate change outcomes for the courtroom.

C. *Erroneous Predictions Plagued Prior Climate Change Models*

Despite the increasing complexity of these models, they still struggle to compete with the complexity of the natural world. Instead, modelers must rely upon calibration in order to reduce uncertainties in the model by adjusting their model to accurately reflect a past event that has already occurred.¹¹⁰ However, calibrating a model to past events provides no certainty that these models will be effective at accurately predicting future events. Instead, calibration may only confirm that a model accurately conforms to the past but does not mean it will accurately predict the future.¹¹¹

IPCC's AR5 identifies three "main" sources of uncertainty in the climate models used to predict future climate change. The first relates to "natural internal variability which is intrinsic to the climate system."¹¹² The second is the existing "uncertainty concerning past, present and future forcing on the climate system by anthropogenic forcing agents," including lack of direct or proxy observations and observational errors.¹¹³ The third is the "uncertainty related to the response of the climate system to the specified forcing agents."¹¹⁴ In other words, the IPCC recognizes that so much is unknown, the variables are so vast, and our ability to analyze them so limited, that no one can be Nostradamus.

The model uncertainties impact the reliability of the IPCC climate change predictions. Indeed, the IPCC has documented that the vast majority of models have not accurately predicted future events. AR5 explained

¹⁰⁹ *See id.*

¹¹⁰ Matthew W. Swinehart, *Remedying Daubert's Inadequacy in Evaluating the Admissibility of Scientific Models Used in Environmental-Tort Litigation*, 86 TEX. L. REV. 1281, 1291 (2008).

¹¹¹ Richard Martin, *Why Climate Models Aren't Better*, MIT TECH. REV. (Nov. 18, 2015), <https://www.technologyreview.com/s/543546/why-climate-models-arent-better/> [<https://perma.cc/5YH4-X5MV>] ("Models are getting more accurate in the sense that they simulate things more realistically, but . . . that has not really helped in decreasing the uncertainty in future projections.").

¹¹² CLIMATE CHANGE 2013, *supra* note 97, at 978.

¹¹³ *Id.*

¹¹⁴ *Id.*

that “[f]or the period from 1998 to 2012, 111 of the 114 available climate-model simulations show a surface warming trend larger than the observations.”¹¹⁵ Thus, the IPCC stated in AR5 that “[s]ome models may be too sensitive to anthropogenic forcing,” which means that the models were assuming a greater effect on temperatures from human activity than what actually turned out to be the case based on actual observed temperatures.¹¹⁶ This inaccuracy appears to reflect the overarching assumption by the global climate models that the increase in carbon dioxide is the driving force behind average global temperature, overlooking “the patterns and timing of multidecadal ocean oscillations” and “future solar variations and solar indirect effects on climate.”¹¹⁷ Whatever the exact reasons, 97 percent of the climate models from 1998 to 2012 were simply incorrect.¹¹⁸

AR5 also noted numerous areas where the current state of climate models cannot match natural phenomena, such as the complex dynamics of clouds. Clouds can have a significant influence on the impact that greenhouse gases have on air temperature.¹¹⁹ As stated in AR5, “Climate models now include more cloud and aerosol processes and their interactions than at the time of the AR4, but there remains *low confidence* in the representation and quantification of these processes in models.”¹²⁰ As stated above, by recognizing “low confidence” in the ability of these models to incorporate fundamental aspects of the natural environment, the models are inherently unreliable to predict the future effects of climate change.

Additionally, the lack of historical data prevents scientists from explaining significant historical climate events. For instance, the AR5 report acknowledges that the available data shows that during times of substantially lower carbon emissions, sea level rise has previously risen at similar rates to those currently being seen, but then levels subsequently fell. The AR noted that “[t]he multi-decadal variability [of global mean sea

¹¹⁵ SYNTHESIS REPORT, *supra* note 93, at 43. In fact, the global climate models resulted in predicted temperature increases twice as high as the observed increases so far during the twenty-first century. JUDITH CURRY, GLOBAL WARMING POLICY FOUND., CLIMATE MODELS FOR THE LAYMAN 14 (2017) (“So far in the 21st century, the GCMs are warming, on average, about a factor of 2 faster than the observed temperature increase.”).

¹¹⁶ CLIMATE CHANGE 2013, *supra* note 97, at 1010; *Anthropogenic Forcing*, REALCLIMATE (Nov. 28, 2004), <http://www.realclimate.org/index.php/archives/2004/11/anthropogenic-forcing/> [<https://perma.cc/8KHF-62FH>].

¹¹⁷ CURRY, *supra* note 115, at 16.

¹¹⁸ See SYNTHESIS REPORT, *supra* note 93, at 43.

¹¹⁹ CLIMATE CHANGE 2013, *supra* note 97, at 676 (“It is shown that clouds can reduce the magnitude of RF due to GHGs by about 25%.”).

¹²⁰ CLIMATE CHANGE 2013, *supra* note 97, at 16 (note that “low confidence” means that a finding is based on limited evidence or low scientific agreement).

level] is marked by an increasing trend starting in 1910–1920, a downward trend . . . starting around 1950, and an increasing trend starting around 1980.”¹²¹ “It is *likely* that [Global Mean Sea Level] rose *between 1920 and 1950* at a rate comparable to that observed *between 1993 and 2010*.”¹²²

D. *Climate Models Cannot Accurately Predict How Climate Change Will Cause Local Impacts*

The majority of the climate predictions in AR5 that are expressed with higher levels of confidence address broader climate trends such as “global mean surface temperature” increases or “global mean sea level rise,” “ocean warming,” or “ocean acidification.”¹²³ This is in contrast to predictions of regional or local climate change impacts, which are subject to more variability and are prone to even greater errors.¹²⁴ Additionally, likely long-term impacts are presented with greater certainty than the impacts of climate change that will occur in the near future.¹²⁵

A major reason for that oddity is that predications of regional climate change impacts are developed by taking global climate change models and “downscaling” inputs to develop regional models.¹²⁶ The IPCC AR5 Report criticized relying on such downscaling:

Downscaling of global climate reconstruction and models has advanced to bring the climate data to a closer match for the temporal and spatial resolution requirements for assessing many regional impacts and the application of downscaled climate data has expanded substantially since AR4. This information remains *weakly coordinated*, and current results indicate that high resolution downscaled

¹²¹ *Id.* at 289; *see also id.* Figure 3.14.

¹²² *Id.* at 258 (emphasis added).

¹²³ *Id.* at 257–59.

¹²⁴ The ultimate source of most such errors is that many important small-scale processes cannot be represented explicitly in models, and so must be included in approximate form as they interact with larger-scale features. Myles Allen et al., *Model Error in Weather and Climate Forecasting*, 8 *NONLINEAR PROCESSES GEOPHYSICS* 275, 279 (2001).

¹²⁵ Andrew C. Revkin, *Failed 2008 Cooling Prediction Shows Short-Term Climate Models Remain a Bad Bet*, N.Y. TIMES: DOT EARTH (Nov. 17, 2015), <https://dotearth.blogs.nytimes.com/2015/11/17/failed-2008-cooling-prediction-shows-short-term-climate-forecasts-remain-a-bad-bet/> [<https://perma.cc/7X7J-9ZCW>].

¹²⁶ *Downscaling*, CLIMATE CHANGE AUSTL., <https://www.climatechangeinaustralia.gov.au/en/climate-campus/modelling-and-projections/climate-models/downscaling/> [<https://perma.cc/KZ9Q-9YJR>] (last visited Dec. 3, 2019).

reconstructions of current climate can have *significant errors*. The increase in downscaled data sets has not narrowed the uncertainty range.¹²⁷

Thus AR5 admits that the available science does not allow accurate predictions of how climate change will affect specific regions and local areas.

This includes predictions of the rise in sea levels. Sea level rise is not uniform throughout the world. “Since the late 20th century, satellite measurements of the height of the ocean surface relative to the center of the Earth (known as geocentric sea level) show differing rates of geocentric sea level change around the world.”¹²⁸ “[T]hose in the eastern Pacific Ocean are lower than the global mean value, with much of the west coast of the Americas experiencing a fall in sea surface height over the same period.”¹²⁹ The AR5 report recognizes that these regional variabilities remain difficult to predict:

While it is likely that extreme sea levels have increased globally since the 1970s, mainly as a result of mean sea level rise due in part to anthropogenic warming, local sea level trends are also influenced by factors such as regional variability in ocean and atmospheric circulation, subsidence, isostatic adjustment, coastal erosion, and coastal modification. As a consequence, the detection of the impact of climate change in observed changes in relative sea level remains challenging.¹³⁰

While AR5 concludes that there is a general “positive value”¹³¹ evidencing a rise in “global mean sea level,” such multi-decadal variability, along with the limited amount of data that is available for vast areas of the Earth’s ocean, prevent more than a general conclusion about rising sea levels.¹³²

¹²⁷ INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE, AR5 CLIMATE CHANGE 2014: IMPACTS, ADAPTION, AND VULNERABILITY, PART B: REGIONAL ASPECTS 1137–38 (2014), https://www.ipcc.ch/site/assets/uploads/2018/02/WGIIAR5-PartB_FINAL.pdf [<https://perma.cc/T5GH-NQL5>] [hereinafter CLIMATE CHANGE 2014, PART B] (emphasis added).

¹²⁸ CLIMATE CHANGE 2013, *supra* note 97, at 1148.

¹²⁹ *Id.*

¹³⁰ *Id.*

¹³¹ *Id.* at 290.

¹³² Benjamin P. Horton et al., *Mapping Sea-Level Change in Time, Space, and Probability*, ANN. REV. ENV’T & RESOURCES 481, 511 (2018).

There is still considerable uncertainty on how long large-scale patterns of regional sea level change can persist, especially in the Pacific where the majority of tide gauge records are less than 40 years long. Based on analyses of the longest records in the Atlantic, Indian and Pacific Oceans (including the available gauges in the Southern Ocean) there are significant multi-decadal variations in regional sea level (Holgate, 2007; Woodworth et al., 2009, 2011; Mitchum et al., 2010; Chambers et al., 2012). Hence local rates of sea level rise can be considerably higher or lower than the global mean rate for periods of a decade or more.¹³³

Plaintiffs in climate change cases also frequently point to the increased risk of coastal flooding in regional or local areas as the basis for their risk of harm.¹³⁴ However, AR5 also specifically disclaimed current science's ability to detect whether any specific instance of coastal flooding is a result of climate change, concluding that “[t]otal damages from coastal flooding have increased globally over the last decades (high confidence); however, with exposure and subsidence constituting the major drivers, confidence in detection of a climate change impact is very low.”¹³⁵

¹³³ CLIMATE CHANGE 2013, *supra* note 97, at 288–89.

¹³⁴ See, e.g., Complaint at ¶ 10, *City of N.Y. v. BP P.L.C.*, 325 F. Supp. 3d 466 (S.D.N.Y. 2018) (alleging that “global warming is already causing the City to suffer increased hot days, flooding of low-lying areas, increased shoreline erosion, and higher threats of catastrophic storm surge flooding even more severe than the flooding from Hurricane Sandy.”); Complaint at ¶¶ 7, 13, *County of Marin v. Chevron Corp.*, No. 1702586 (Cal. Super. Ct. filed July 17, 2017) (alleging that “Defendants are directly responsible for a substantial portion of committed sea level rise” which will cause the County to suffer “increased inundation (permanent) and flooding (temporary); . . . aggravated wave impacts, including erosion, damage, and destruction of built structures; . . . changes in sediment supply that could alter or destroy natural coastal habitats like beaches and wetlands; . . . saltwater intrusion on groundwater aquifers, agricultural land, and infrastructure; and magnification of other climate change impacts, due to the superimposition on sea level rise on shifts in precipitation patterns that result in more rain and attendant flooding; increased frequency and severity of storms that cause erosion, flooding, and temporary sea level rise increases; and others.”); Complaint at ¶ 8, *Rhode Island v. Chevron Corp.*, No. PC-2018-4716 (R.I. Super. Ct. July 2, 2018) (stating that “[a]s a direct and proximate consequence of Defendants’ wrongful conduct, . . . flooding, extreme precipitation events such as tropical storms and hurricanes, and drought will become more frequent and more severe” along Rhode Island’s coast).

¹³⁵ INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE, AR5 CLIMATE CHANGE 2014: IMPACTS, ADAPTION, AND VULNERABILITY, PART A: GLOBAL AND SECTORAL ASPECTS 993 (2014), https://www.ipcc.ch/site/assets/uploads/2018/02/WGIIAR5-PartA_FINAL.pdf [<https://perma.cc/S356-GZ9T>] (emphasis omitted).

Similarly, with respect to the other types of potential harms alleged by plaintiffs, the AR5 report admitted that current research has not been able to show that climate change has had an impact on the behavior of severe storms,¹³⁶ the frequency of the El Niño–Southern Oscillation weather pattern,¹³⁷ the likelihood of more intense and longer droughts,¹³⁸ or impacts to water quality.¹³⁹

Additionally, with respect to regional variabilities, researchers have also not been able to explain why, in large areas of the Antarctic, sea ice has increased, rather than decreased, in recent years. The IPCC found that “[t]here is low confidence in the scientific understanding of the small observed increase in Antarctic sea ice extent due to the incomplete and competing scientific explanations for the causes of change and low confidence in estimates of natural internal variability in that region.”¹⁴⁰ The IPCC also found that “[d]ue to a low level of scientific understanding there is low confidence in attributing the causes of the observed loss of mass from the Antarctic ice sheet over the past two decades.”¹⁴¹

In fact, the IPCC has identified climate change as playing only a “minor role” with respect to the various types of alleged extreme-weather harms identified by plaintiffs as providing standing for their lawsuits against various energy companies.¹⁴² In short, the current science reflected in the AR5 report does not permit an expert to reliably testify to the type

¹³⁶ *Id.* (“Recent global and regional studies have found increases in extreme sea levels consistent with mean sea level trends, indicating that the increasing frequency of extreme water levels affecting coastal infrastructures observed so far is related to rising mean sea level rather than to changes in the behavior of severe storms. . . . [T]here is a shortage of studies discussing the role of climate change in observed impacts on coastal systems.”) (internal citations omitted); *see also id.* at 998 (“Studies of normalized losses from extreme winds associated with hurricanes in the USA and the Caribbean, tornadoes in the USA, and wind storms in Europe *have failed to detect trends consistent with anthropogenic climate change.*”) (emphasis added, internal citations omitted).

¹³⁷ CLIMATE CHANGE 2013, *supra* note 97, at 23 (“Natural variations of the amplitude and spatial pattern of ENSO are large and thus confidence in any specific projected change in ENSO and related regional phenomena for the 21st century remains low.”).

¹³⁸ CLIMATE CHANGE 2014, PART B, *supra* note 127, at 988 (“Since the 1950s some regions of the world have experienced more intense and longer droughts, although a global trend currently cannot be established. Longer drought periods have affected groundwater recharge, but changes in groundwater storage are generally difficult to attribute to climate change, due to confounding factors from human activities.”) (internal citations omitted).

¹³⁹ *Id.* (“Likewise, confounding factors do not permit attribution of observed changes in water quality to climate change.”).

¹⁴⁰ CLIMATE CHANGE 2013, *supra* note 97, at 19.

¹⁴¹ *Id.*

¹⁴² *Id.* at 1014; *id.* at Table 18-10.

of opinions that would be necessary to sustain plaintiffs' actions seeking damages against individual defendants on the basis of climate change.

V. TRIAL COURTS MUST STRICTLY APPLY THEIR GATEKEEPER ROLES IN CLIMATE CHANGE LITIGATION

The gatekeeper responsibilities set forth in *Daubert* and *Sargon* are particularly critical to climate change cases alleging localized impacts. This area of science involves issues of staggering complexity. A jury made up of laypersons will have significant difficulty distinguishing between opinions supported by adequate data, and those based on exaggerated or misapplied "facts." The trial court has a responsibility to ensure that the jury hears evidence that is sufficiently reliable.

This gatekeeper function is also critical because the topic of climate change has become highly political and polarizing, which heightens the risk that any case is resolved on the basis of personal politics instead of the evidence submitted to the jury. Recent scholarship has shown a large and growing divide between how people view climate change based on their political and ideological views.¹⁴³ Thus, cross-examination of opposing experts is likely to have limited effect. A trial court cannot simply allow questionable material to be weighed and considered by the jury in the hopes that the jury will be able to determine whether the opinion has merit. Instead, the trial judge has an obligation to ensure that the expert testimony is reliable and supported by the underlying data.¹⁴⁴

Expert opinion testimony is deemed sufficiently reliable if the expert has "good grounds" for his or her testimony—i.e., if the expert's conclusions are based on the knowledge and experience of his or her discipline rather than on "subjective belief or unsupported speculation."¹⁴⁵ The *Daubert* and *Sargon* standards set forth clear restrictions against allowing unreliable testimony and evidence into the jury room. Evidence that is inadmissible under these standards is not limited to "junk science" or frivolous studies. Serious, heavily funded, and complicated research

¹⁴³ J.T. Carmichael et al., *The Great Divide: Understanding the Role of Media and other Drivers of the Partisan Divide in Public Concern Over Climate Change in the USA, 2001–2014*, 141 CLIMATIC CHANGE 599 (2017); 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, 16 (2016).

¹⁴⁴ *Daubert v. Merrell Dow Pharm., Inc.*, 509 U.S. 579, 579 (1993).

¹⁴⁵ *Id.* at 590; see also *Sargon Enterprises, Inc. v. Univ. of S. Cal.*, 288 P.3d 1237, 1239 (Cal. 2012) ("conclud[ing] that the trial court has the duty to act as a 'gatekeeper' to exclude speculative expert testimony.").

will still fail to satisfy these standards if it is insufficiently reliable to meet the legal standard.

Expert opinions should also be excluded under *Daubert* where the conclusions are divorced from the underlying data being relied upon. “A court may conclude that there is simply too great an analytical gap between the data and the opinion proffered.”¹⁴⁶ Notwithstanding a trial court’s potential reluctance to delve into the complexities of the climate models being submitted by the proposed experts in these cases (i.e., “let the jury decide”) the court has an obligation to the court system and to the jury to exclude unreliable and improper materials.¹⁴⁷

A. *Climate Models Cannot Be Tested and Are Not Subject to Being Proved to Be True or False*

In *Daubert*, the Supreme Court recognized that testing hypotheses and seeing if they can be falsified is the critical component that separates scientific knowledge from other fields of human inquiry:

Ordinarily, a *key question* to be answered in determining whether a theory or technique is scientific knowledge that will assist the trier of fact will be whether it can be (and has been) tested. “Scientific methodology today is based on generating hypotheses and testing them to see if they can be falsified; indeed, this methodology is what distinguishes science from other fields of human inquiry.”¹⁴⁸

¹⁴⁶ *General Electric Co. v. Joiner*, 522 U.S. 136, 146 (1997).

¹⁴⁷ See, e.g., *McClain v. Metabolife Int’l, Inc.*, 401 F.3d 1233, 1255 (11th Cir. 2005) (finding that “the trial court abused its discretion . . . by abdicating its gatekeeper responsibilities”); *Elsayed Mukhtar v. Cal. State Univ., Hayward*, 299 F.3d 1053, 1066 (9th Cir. 2002) (vacating the admission of expert testimony as the court “abdicated its gatekeeping role by failing to make any determination that [the expert’s] testimony was reliable”).

¹⁴⁸ *Daubert*, 509 U.S. at 593 (emphasis added) (quoting Michael D. Green, *Expert Witnesses and Sufficiency of Evidence in Toxic Substances Litigation: The Legacy of Agent Orange and Bendectin Litigation*, 86 NW. U. L. REV. 643, 645 (1992)); see *id.* (quoting CARL G. HEMPEL, *PHILOSOPHY OF NATURAL SCIENCE* 49 (1966) (“[T]he statements constituting a scientific explanation must be capable of empirical test.”)); *id.* (quoting KARL R. POPPER, *CONJECTURES AND REFUTATIONS: THE GROWTH OF SCIENTIFIC KNOWLEDGE* 37 (5th ed. 1989) (“[T]he criterion of the scientific status of a theory is its falsifiability, or refutability, or testability.”)); see also *Nease v. Ford Motor Co.*, 848 F.3d 219, 232 (4th Cir. 2017) (excluding expert testimony where the expert “presented a hypothesis only—he failed to validate it with testing”).

The court specifically noted that scientific methodology involves “generating hypotheses and testing them to see if they can be falsified.”¹⁴⁹

Here, climate models are tested by determining whether the model can duplicate historical climate conditions. However, due to the complexity of the climate, the fact that a model can duplicate the past is no guarantee that it will be able to forecast the future. Additionally, all of the models have starting points, referred to as “initializations” or subjective inputs, so it is not possible to compare the accuracy of one model against another.

The fundamental problem [is] the lack of an objective metric or norm for model error: we have no way of measuring the distance between two models or model-versions in terms of their input parameters or structure in all but a trivial and irrelevant subset of cases. Hence there is no way of allowing for model error by sampling the space of all possible models in a representative way, because distance within this space is undefinable. If the only way of measuring model similarity is in terms of outputs, complications arise when we also wish to use these outputs to compare with observations in the initialisation of a forecast. These problems are particularly acute in seasonal or climate forecasting where the range of relevant observational datasets is extremely limited. Naive strategies run the risk of using observations twice and hence underestimating uncertainties by a significant margin.¹⁵⁰

In other areas of law, there has been a recognition that the ability to measure the accuracy of a methodology is an essential component for its admissibility as reliable evidence. In 2016, President Obama’s Council of Advisors on Science and Technology (“PCAST”) released a report on forensic science, reviewing 2,100 scientific papers over a year-long study, to study the validity and accuracy of methods used for testing forensic evidence in criminal cases.¹⁵¹ The report highlighted the importance of testing forensic methods:

¹⁴⁹ *Daubert*, 509 U.S. at 593.

¹⁵⁰ Allen et al., *supra* note 124, at 225.

¹⁵¹ See PRESIDENT’S COUNCIL OF ADVISORS ON SCI. & TECH., EXEC. OFFICE OF THE PRESIDENT, FORENSIC SCIENCE IN CRIMINAL COURTS: ENSURING SCIENTIFIC VALIDITY OF FEATURE-COMPARISON METHODS 1–2 (2016), https://obamawhitehouse.archives.gov/sites/default/files/microsites/ostp/PCAST/pcast_forensic_science_report_final.pdf [<https://perma.cc/8VPV-CGWB>].

An empirical measurement of error rates is not simply a desirable feature; it is *essential* for determining whether a method is *foundationally valid*. In science, a testing procedure—such as testing whether a person is pregnant or whether water is contaminated—is *not considered valid* until its reliability has been empirically measured.¹⁵²

As explained in the PCAST report, “[t]he method need not be perfect, but it is *clearly essential* that its accuracy has been measured based on appropriate empirical testing and is high enough to be appropriate to the application.”¹⁵³ “Without an appropriate estimate of its accuracy, a metrological method is useless—because one has no idea how to interpret its results.”¹⁵⁴

As climate models cannot be easily tested, there is little information about the potential rate of error for these models. The potential rate of error with respect to a particular model’s prediction is determined by future events that cannot be known. And because these models generally attempt to predict events occurring thirty years or more into the future, courts considering these models for admission will not be able to determine their accuracy for many decades. Their reliability is therefore inherently suspect.

B. *The Known Error Rate Does Not Support Admissibility*

In *Daubert*, the Supreme Court noted that the known or potential rate of error is a factor in determining the admissibility of scientific evidence.¹⁵⁵ As discussed above, the only evidence of error rates must be drawn from the historical record of climate models that have previously made predictions regarding future temperatures. The high error rate in the ability of past climate models to predict future events undermines the reliability of such models in litigation.¹⁵⁶ The AR5 report shows that climate models have had an abysmal record predicting the future with 111 of 114 models reporting greater warming than what has actually been observed for the period from 1998 to 2012; or a 97 percent error rate.¹⁵⁷

¹⁵² *Id.* at 53 (emphasis added).

¹⁵³ *Id.* at 48 (emphasis added).

¹⁵⁴ *Id.*

¹⁵⁵ *Daubert v. Merrell Dow Pharm., Inc.*, 509 U.S. 579, 594 (1993).

¹⁵⁶ *See supra* Section IV.C.

¹⁵⁷ SYNTHESIS REPORT, *supra* note 93, at 43.

While the models themselves have wide levels of variability, they have shown significant inaccuracy in predicting the observed data. Although not without controversy, most scientists acknowledge that there has been a “pause” in global warming during the start of the twenty-first century (roughly from 1998 to 2012), which varies from the IPCC’s model predictions.¹⁵⁸ Even scientists who do not accept the fact that there has been a “pause” acknowledge that there is significant variability in climate change and climate change predictions.¹⁵⁹ This acknowledged variability does not allow for the necessary level of reliability to satisfy *Daubert*. In short, the error rates for these climate models militate against admissibility of this evidence.

C. *Climate Models Based on Speculation Must Be Excluded*

Courts have a duty to be particularly vigilant about predictions of the future. For any judge, it is a fundamental principle that expert opinions cannot rely upon conjecture or speculation. As stated in *People v. Richardson*, “[e]xclusion of expert opinions that rest on guess, surmise or conjecture is an inherent corollary to the foundational predicate for admission of the expert testimony: will the testimony assist the trier of fact to evaluate the issues it must decide?”¹⁶⁰ In *Sargon*, the Court went further in cautioning lower courts against allowing experts to provide speculative assertions regarding future events:

World history is replete with fascinating “what ifs.” . . . Many serious, and not-so-serious, historians have enjoyed speculating about these what ifs. But few, if any, claim they are considering what *would* have happened rather than what *might* have happened. Because it is *inherently difficult to accurately predict the future* or to accurately reconstruct a counterfactual past, it is appropriate that trial

¹⁵⁸ See Rebecca Lindsey, *Did global warming stop in 1998?*, CLIMATE.GOV (Sept. 4, 2018), <https://www.climate.gov/news-features/climate-qa/did-global-warming-stop-1998> [<https://perma.cc/W8GF-S7NQ>].

¹⁵⁹ CLIMATE CHANGE 2013, *supra* note 97, at 960 (“Because of the chaotic and nonlinear nature of the climate system small differences, in initial conditions or in the formulation of the forecast model, result in different evolutions of forecasts with time.”).

¹⁶⁰ *People v. Richardson*, 183 P.3d 1146, 1179 (Cal. 2008) (quoting *Jennings v. Palomar Pomerado Health Sys., Inc.*, 114 Cal. App. 4th 1108, 1117 (2003)).

courts *vigilantly exercise* their gatekeeping function when deciding whether to admit testimony that purports to prove such claims.¹⁶¹

It is acknowledged among the scientific community that there are various levels of uncertainty relating to science's ability to predict future climate change. There is some agreement on the reliability of broad climate change trends but much less agreement on efforts to accurately predict the local impacts of those broader trends. Even the climate change reports from the IPCC recognize the substantial uncertainty in providing opinions regarding future regional or local impacts of climate change.¹⁶² Numerous reports acknowledge that regional climate change predictions have an equal chance of being wrong as they have of being right.¹⁶³ These reports specifically disclaim any ability to predict with reasonable confidence whether specific areas will be impacted by climate change.¹⁶⁴

The IPCC has carefully specified its position regarding the degree of confidence to which the current state of the science can be expected to predict certain events.¹⁶⁵ As to those areas that will be critical for plaintiffs to establish a traceable injury in order to show standing, the IPCC has already admitted that the current models would not allow an expert to reliably testify that climate change will cause these events to occur.¹⁶⁶ Without sufficient certainty, any predictions that future events will be caused by climate change fail to satisfy the requirement of reliability set forth in *Daubert* and *Sargon*.¹⁶⁷

¹⁶¹ *Sargon Enterprises, Inc. v. Univ. of S. Cal.*, 288 P.3d 1237, 1257–58 (Cal. 2012) (emphasis added) (excluding expert whose “attempt to predict the future was in no way grounded in the past”).

¹⁶² See *supra* Section IV.D and accompanying notes.

¹⁶³ Pa. State Univ., *Global climate models do not easily downscale for regional predictions*, SCIENCE DAILY (Aug. 24, 2016), <https://www.sciencedaily.com/releases/2016/08/160824144031.htm> [<https://perma.cc/ZUJ7-SXDT>]. See generally Marshall Burke et al., *Incorporating Climate Uncertainty into Estimates of Climate Change Impacts*, 97 REV. ECON. & STAT. 461 (2015) (discussing uncertainties in climate modeling).

¹⁶⁴ See CLIMATE CHANGE 2013, *supra* note 97; CLIMATE CHANGE 2014, PART B, *supra* note 127; see also Martin, *supra* note 111 (“Climate models are not good predictors of specific climate effects, such as the melting of the sea ice or the frequency of major hurricanes in the north Atlantic.”).

¹⁶⁵ See SYNTHESIS REPORT, *supra* note 93, at 2 n.1.

¹⁶⁶ *Id.* at 109.

¹⁶⁷ See *Daubert v. Merrell Dow Pharm., Inc.*, 509 U.S. 579, 597 (1993); *Sargon Enterprises, Inc. v. Univ. of S. Cal.*, 288 P.3d 1237, 1250–53 (Cal. 2012).

CONCLUSION

Climate models are not sufficiently reliable to allow for the admission of expert opinions regarding a particular actor's contribution to global warming in a localized region of the world. These climate models are not appropriate for and do not support the "particularized resolution of legal disputes."¹⁶⁸ Accordingly, expert opinions based on these models are properly excluded as insufficiently reliable.

¹⁶⁸ *Daubert*, 509 U.S. at 597.