

## The Children's Climate Lawsuit: A Critique of the Substance and Science of the Preeminent Atmospheric Trust Litigation Case

Bronson Pace

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**THE CHILDREN'S CLIMATE LAWSUIT: A CRITIQUE OF THE  
SUBSTANCE AND SCIENCE OF THE PREEMINENT  
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UNITED STATES**

BRONSON J. PACE

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# THE CHILDREN’S CLIMATE LAWSUIT: A CRITIQUE OF THE SUBSTANCE AND SCIENCE OF THE PREEMINENT ATMOSPHERIC TRUST LITIGATION CASE, JULIANA V. UNITED STATES

BRONSON J. PACE\*

## ABSTRACT

*Juliana v. United States is a federal district court case consisting of children plaintiffs claiming that the federal government is violating their fundamental right to a climate system capable of sustaining human life. Under the Atmospheric Trust Litigation strategy, the children claimed that their fundamental right must be secured and protected by the federal government pursuant to public trust obligations. By succeeding the United States’ motion to dismiss, the children have secured a trial date—set for October 29, 2018.<sup>1</sup> The merits of the children’s claims consist of an amalgam of science and law. In addition to a declaration of a fundamental right, the relief sought includes a climate recovery plan reliant upon the best available science within the climate science field. The children’s allegation of governmental infringement stems from the federal government’s ostensibly favorable connection with the fossil fuel industry. In light of the scientific consensus linking human-induced fossil fuel emissions to the proliferation of climate change, the children alleged that the federal government is a major contributor to the detriment of its citizens’ health and welfare—in violation of its fiduciary duty. This Article critically examines the children’s substantive claims and contemplates upon the science that informs those claims. Beyond the scientific and legal components, this Article also extrapolates upon the extra-legal effects, with respect to the social and ethical considerations of intergenerational equity and promotes further interdisciplinary research on this topic.*

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\* J.D. candidate, University of Idaho College of Law, 2019; Ph. D. student, Institute for Waters of the West, Water Resources: Law, Management, and Policy, University of Idaho College of Agricultural and Life Sciences, 2022. This Article is dedicated to Professor Barbara Cosens, who has been an inspiration and mentor for my academic endeavors at the interface of science and law.

1. One week prior to the set trial date, proceedings were stayed pending the Ninth Circuit’s decision regarding the government’s petition for interlocutory appeal. On December 26, 2018, the Ninth Circuit granted the government’s petition, and, as of this writing’s publishing, trial remains postponed and the children await oral arguments before the Ninth Circuit—scheduled for the week of June 3rd, 2019. See generally *Juliana v. United States*, CLIMATE CHANGE LITIG. DATABASES, [climatecasechart.com/case/juliana-v-united-states/](http://climatecasechart.com/case/juliana-v-united-states/) (last visited Mar. 20, 2019).

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## I. INTRODUCTION

*Juliana v. United States* is a case concerning climate change and the federal government’s obligation to address it.<sup>2</sup> On its surface, the *Juliana* case is a lawsuit seeking to compel the government to implement a national, science-based, climate recovery plan designed to reduce atmospheric CO<sub>2</sub> concentrations below 350 ppm by the year 2100.<sup>3</sup> Below the surface, the plaintiffs, a group of twenty-one youths represented by a non-profit organization called Our Children’s Trust, are seeking a declaration of a fundamental right to a climate system capable of sustaining human life.<sup>4</sup> With that, the children are demanding that the government be held liable, as fiduciaries, to maintain an atmosphere free of substantial impairment.<sup>5</sup> As the *Juliana* court aptly stated in its opening line— “[t]his is no ordinary lawsuit.”<sup>6</sup>

The *Juliana* opinion was written by Judge Ann Aiken in the District Court for the District of Oregon.<sup>7</sup> Judge Aiken’s task was to review the United States’ motion

2. See generally *Juliana v. United States*, 217 F. Supp. 3d 1224, 1234 (D. Or. 2016).

3. *Id.*; Carbon dioxide, abbreviated as CO<sub>2</sub>, is a colorless and odorless gas produced by burning carbon and other organic compounds. NAT’L CTR. FOR BIOTECHNOLOGY INFO., *Carbon Dioxide*, PUBCHEM, [https://pubchem.ncbi.nlm.nih.gov/compound/carbon\\_dioxide#section=Pharmacology-and-Biochemistry](https://pubchem.ncbi.nlm.nih.gov/compound/carbon_dioxide#section=Pharmacology-and-Biochemistry) (last visited Mar. 18, 2019). Parts per million (ppm) is a unit of measurement frequently used by scientists to measure the concentration of contaminants in the atmosphere. *Id.*

4. See *Juliana v. U.S. – Climate Lawsuit*, OUR CHILDREN’S TRUST, <https://www.ourchildrenstrust.org/us/federal-lawsuit/> (last visited Mar. 18, 2019).

5. *Id.*

6. *Juliana*, 217 F. Supp. 3d. at 1234.

7. *Id.* at 1233.

to summarily dismiss the children's claims. Although this case is at a relatively early stage in the civil litigation process, it presents intriguing legal and social consequences and is potentially far-reaching with respect to its impact on environmental law jurisprudence. This is a case of first impression, and it is important because of (1) what it is about—the rights of future generations to a viable atmosphere, and (2) the legal tool the children attempt to use—that is, that protecting this right is the obligation of the government as trustee for the public trust.<sup>8</sup>

The children's lawsuit is part of the much larger Atmospheric Trust Litigation movement. With the purpose of spotlighting intergenerational equity, this global movement invokes the judiciary to act as the vehicle to mitigate common pool resource deterioration in the face of climate change. This novel approach to litigation recognizes the limitations to current governance and obstacles to action and finds a unique legal avenue to demand government action. This Article provides only a portion of the research necessary to explore the full potential of the Atmospheric Trust Litigation movement. Further interdisciplinary research may improve an understanding of the ways law, science, and society entwine—a comprehension that may improve legal and social outcomes for complex, intergenerational issues such as climate change.

This Article is structured into five main parts, beginning with Part I, this introduction. Part II covers the facts of the case, prior and subsequent history, and the court's holding. Part III examines the court's reasoning for concluding that the children's substantive claims are viable. This Article concludes that the court was correct in its holding because (1) the children's Due Process claim adequately alleged a fundamental right sufficient for the court to use its reasoned judgment to declare a climate system capable of sustaining human life as part and parcel to the rights of life, liberty, and property; and (2) the public trust claim was correct because (a) the atmosphere fits squarely within the scope of the public trust assets, (b) the Public Trust Doctrine applies to the federal government, (c) the Public Trust Doctrine has not been displaced by way of congressional acts, and (d) the children maintain a cause of action sufficient to enforce the public trust claim in federal court.

Part IV delves into the science that informs the case. In representing the best available science concerning actions necessary to avert climate catastrophe, referred to as the Hansen prescription, the science informing the case affirms the scientific consensus, maintaining high confidence, within the climate science field.

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8. The children's "Prayer for Relief" asks the federal district court, in addition to a declaration, that the United States has violated the children's fundamental rights and its public trust obligations to: (1) "Enjoin the United States from further violation;" (2) "Declare the Energy Policy Act, § 201, to be unconstitutional on its face;" (3) "Declare DOE/FE Order No. 3041, granting long-term multi-contract authorization to Jordan Cove Energy for LNG exports from its Coos Bay terminal, to be unconstitutional as applied and set aside;" (4) Order the United States to "prepare a consumption-based inventory of U.S. CO<sub>2</sub> emissions;" (5) Order the United States to "prepare and implement an enforceable national remedial plan to phase out fossil fuel emissions and draw down excess atmospheric CO<sub>2</sub> so as to stabilize the climate system and protect the vital resources on which [the children] now and in the future will depend;" (6) "Retain jurisdiction over this action to monitor and enforce [the United States'] compliance with the national remedial plan and all associated orders of this Court;" and (7) "Grant such other and further relief as the Court deems just and proper." (See First Amended Complaint for Declaratory and Injunctive Relief at 94–95, *Juliana v. United States*, 217 F. Supp. 3d 1224 (D. Or. 2016) (No. 6:15-cv-01517-TC) [hereinafter Amended Complaint].

Part V consists of a reflection piece that reiterates the noteworthiness of this case and inspects the challenges and opportunities that lie ahead—including an economic examination and an extrapolation of alternative scenarios, with respect to the outcome of the upcoming trial. Finally, Part VI provides the conclusion to this Article. This Article concludes that because of the failure of the political branches of the federal government to protect public trust assets for rising generations, the judicial branch should be enabled to safeguard the children’s fundamental right to a viable climate system in the face of human-induced climate change.

## II. CASE HISTORY, FACTS, AND HOLDING

*Juliana v. United States* was originally filed in 2015 during the Obama administration.<sup>9</sup> Subsequently, the major interests of the fossil fuel industry joined defendants as interveners, and the Trump administration took over as defendants.<sup>10</sup> The United States, shortly after the children filed their claims, filed a motion to dismiss under both the political question and constitutional standing doctrines.<sup>11</sup> In addition to deciding the procedural threshold issues, Judge Aiken examined the viability of the children’s substantive claims. Judge Aiken issued the opinion and order by way of adopting Magistrate Judge Thomas Coffin’s “Findings and Recommendations,” which rejected the United States’ motion to dismiss and advanced the viability of the children’s substantive claims.<sup>12</sup>

Although this Article focuses on the children’s substantive claims, it is contextually important to recognize the procedural arguments. Essentially, the United States argued that what the children are asking the courts to do is far beyond the jurisdiction and power of the judicial branch and an encroachment on the power of the executive and legislative branches.<sup>13</sup> The children countered this argument by positing that the judicial branch’s role of safeguarding the people from wrongful government action, all while prompting active and responsible action by the executive and legislative branches, is indeed an essential and obligatory role of the courts and thus well within the jurisdiction and power of the judicial branch.<sup>14</sup>

The children’s substantive claims challenged “the policies, acts, and omissions of the President of the United States” and his administration.<sup>15</sup> The children’s claims focused on the government’s historic and present contributions to the development of the fossil fuel industry.<sup>16</sup> The children argued that the federal government has acted with “deliberate indifference” through its “promotion, subsidization, and

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9. Complaint for Declaratory and Injunctive Relief, *Juliana v. United States*, 217 F. Supp. 3d 1224 (D. Or. 2016) (No. 6:15-cv-01517-TC), 2015 WL 4747094.

10. *Juliana*, 217 F. Supp. 3d at 1233. The fossil fuel industry, as interveners, are comprised of more than 14,000 members of the coal, oil, and natural gas industries, petroleum refiners, and petrochemical manufacturers. Order Granting Motion to Withdraw at 1, *Juliana v. United States*, 217 F. Supp. 3d 1224 (D. Or. 2016) (No. 6:15-cv-01517-TC).

11. *Juliana*, 217 F. Supp. 3d at 1233.

12. *Id.*

13. *See id.* at 1235.

14. *Id.*

15. *Id.* at 1234.

16. *See* Amended Complaint, *supra* note 8, at 3.

authorization of the fossil fuel industry.”<sup>17</sup> The children maintained that the government’s deliberate indifference is directly causing, and will further cause, substantial impairment to the climate system.<sup>18</sup> With that, the children explained that the federal government’s subsidy of the fossil fuel industry is the reason why fossil fuel energy is the cheapest and most widely available energy, as opposed to alternative forms.<sup>19</sup> This economic support extended toward the continuance of fossil fuel energy, the children added, is placing a devastating cost on future generations—including the costs of pollution on human health and costs of present and future climate disruption.<sup>20</sup>

Furthermore, the children alleged that the federal government has known for over fifty years about the science that burning fossil fuels was causing global warming and climate change.<sup>21</sup> The children added that the government knew that prolonged emissions were destabilizing the climate system and thus causing increased climate disasters for both present and future generations.<sup>22</sup> Notwithstanding this knowledge, the children contended, the federal government continues to advance emission rates throughout the territories of the United States.<sup>23</sup>

Therefore, the children demanded that, in addition to a declaration of a fundamental right, the atmosphere must be recognized as an essential component of the public trust assets and, thus, must be actively monitored and protected by the federal government.<sup>24</sup> That is, the children claimed that the federal government owes, as fiduciaries, active maintenance of the atmospheric system to sustain it for present and future generation beneficiaries.<sup>25</sup> Moreover, the children sought a judicial order declaring a fundamental right to children and future generations to a stable and healthy climate system, which the United States must actively address and protect via public trust obligations.<sup>26</sup>

Since the court’s decision denying the United States’ motion to dismiss was issued on November 10, 2016, a trial date was subsequently scheduled for February

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17. *Id.*; “The United States federal and state governments gave away \$20.5 billion a year on average in 2015 and 2016 in production subsidies to the oil, gas, and coal industries, including \$14.7 billion in federal subsidies and \$5.8 billion through state-level incentives.” Janet Redman, *Dirty Energy Dominance: Dependent on Denial, How the U.S. Fossil Fuel Industry Depends on Subsidies and Climate Denial*, OIL CHANGE INT’L 5 (Oct. 2017), [http://priceofoil.org/content/uploads/2017/10/OCI\\_US-Fossil-Fuel-Subs-2015-16\\_Final\\_Oct2017.pdf](http://priceofoil.org/content/uploads/2017/10/OCI_US-Fossil-Fuel-Subs-2015-16_Final_Oct2017.pdf).

18. See Amended Complaint, *supra* note 8, at 33.

19. *Id.* at 60.

20. *Id.*; see also James Hansen et al., *The Case for Young People and Nature: A Path to a Healthy, Natural, Prosperous Future* 22, (Paper has not yet been submitted for publication, [http://www.columbia.edu/~jeh1/mailings/2011/20110505\\_CaseForYoungPeople.pdf](http://www.columbia.edu/~jeh1/mailings/2011/20110505_CaseForYoungPeople.pdf)) (last visited Mar. 18, 2019).

21. *Juliana*, 217 F. Supp. 3d at 1233.

22. See Amended Complaint, *supra* note 8, at 1.

23. *Id.*

24. See *id.* at 94.

25. See *id.* at 81.

26. *Juliana*, 217 F. Supp. 3d at 1249.

5, 2018.<sup>27</sup> However, in late 2017, the United States filed a petition for a writ of mandamus seeking to bar the children’s lawsuit from proceeding to trial.<sup>28</sup> The United States argued that the district court had committed clear error in denying the motion to dismiss and was acting outside its jurisdiction.<sup>29</sup> Oral arguments took place on December 11, 2017, in front of the Ninth Circuit Court of Appeals, and a temporary stay was issued by the Ninth Circuit’s three-judge panel.<sup>30</sup> On March 7, 2018, the Ninth Circuit unanimously denied the United States’ writ of mandamus, advancing the case to trial on the merits—with plans to commence on October 29, 2018.<sup>31</sup>

### III. ANALYSIS OF THE CHILDREN’S SUBSTANTIVE CLAIMS

The analysis section is laid out as follows: Part A examines the children’s constitutional due process claims—including the obligation of the government to afford due process in situations where the government acts—or fails to act—in the face of climate change. Next, Part B examines the children’s Public Trust Doctrine claim and the restrictions it imposes on the government—including the requirement that the public trust property be held available for use by the general public and be actively maintained.

The court was correct in holding that both of the children’s claims are viable.<sup>32</sup> First, the due process claim is correct because the children adequately alleged, comports with precedent derived from *Obergefell v. Hodges*, a fundamental right necessary to implicate strict scrutiny review of government action.<sup>33</sup> With that, the court correctly found that the children identified the criteria sufficient to effectuate the danger creation exception, which forbids the government from omitting action because of its causal relationship to the danger.<sup>34</sup> Second, the Public Trust Doctrine claim was correct because the atmosphere is a public trust asset, the Public Trust Doctrine applies to the federal government and has not been displaced, and the children have a cause of action sufficient to enforce the public trust claim in federal court.<sup>35</sup>

#### A. Due Process Claim

The Due Process Clause of the Fifth and Fourteenth Amendments forbids the government from taking a person’s life, liberty, or property without due process of law.<sup>36</sup> Procedural due process examines whether the government has followed

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27. See generally *Juliana v. United States*, CLIMATE CHANGE LITIG. DATABASES, <http://climate-casechart.com/case/juliana-v-united-states/> (last visited Mar. 18, 2019).

28. *Id.*

29. *Id.*

30. *Id.*

31. *Id.*, but see CLIMATE CHANGE LITIG. DATABASES, *supra* note 1.

32. *Juliana*, 217 F. Supp. 3d at 1253.

33. *Id.* at 1249.

34. *Id.* at 1253.

35. *Id.* at 1252–61.

36. The Fifth Amendment states that no person shall “be deprived of life, liberty, or property, without due process of law[.]” U.S. CONST. amend. V. The Fourteenth Amendment states that no state shall “deprive any person of life, liberty, or property, without due process of law[.]” U.S. CONST. amend. XIV.



proper procedures when taking away someone's life, liberty or property.<sup>37</sup> Substantive due process examines whether the government has an adequate reason for taking away life, liberty or property.<sup>38</sup> A person cannot have a procedural due process claim unless the government is depriving them of an interest in life, liberty, or property.<sup>39</sup> This means that individuals may only challenge a government action if a recognized interest is involved.

Procedural due process requires a court to have personal jurisdiction over an individual and that the individual be given adequate notice and a fair trial before an unbiased decision-maker.<sup>40</sup> Interests in life, liberty, or property are various and complex. When an individual's life is deprived, procedural due process is implicated.<sup>41</sup> With respect to liberty interests, there are two main types: the freedom from physical constraints and personal security, as well as family autonomy.<sup>42</sup> Family autonomy includes an array of interests related to the raising of children or other family matters.<sup>43</sup> In addition to liberty, the Due Process Clause protects property interests—including traditional property and government benefits or employment.<sup>44</sup>

Substantive due process claims often concern the right to privacy or personal autonomy. If the government takes an action that infringes on a substantive, fundamental right, a reviewing court will apply strict scrutiny.<sup>45</sup> Strict scrutiny demands that the government's action be narrowly tailored to achieve a compelling governmental interest to be held constitutional.<sup>46</sup> Courts applying strict scrutiny show very little deference to legislatures,<sup>47</sup> and legislation subjected to this standard is most frequently struck down.

The Ninth Amendment implicates that there may be found fundamental rights not specifically enumerated in the Bill of Rights.<sup>48</sup> Specifically, the Ninth Amendment states that "[t]he enumeration in the Constitution, of certain rights, shall not be construed to deny or disparage others retained by the people."<sup>49</sup> The Supreme Court has recognized a variety of unenumerated fundamental rights, consistent

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37. See *Mathews v. Eldridge*, 424 U.S. 319, 332 (1976).

38. See generally *Planned Parenthood of Se. Pa. v. Casey*, 505 U.S. 833 (1992).

39. See *Mathews*, 424 U.S. at 332.

40. See *Mullane v. Cent. Hanover Trust Co.*, 339 U.S. 306, 314 (1950); see also *Fuentes v. Shevin*, 407 U.S. 67, 80–81 (1972).

41. See U.S. CONST. amend. V.

42. See generally *Youngberg v. Romeo*, 457 U.S. 307 (1982); see also *Planned Parenthood of Se. Pa.*, 505 U.S. at 833.

43. See *Ingraham v. Wright*, 430 U.S. 651 (1977); see also *Armstrong v. Manzo*, 380 U.S. 545 (1965).

44. See *Mathews*, 424 U.S. at 333.

45. See *Adarand Constructors, Inc. v. Peña*, 515 U.S. 200, 237 (1995).

46. See generally *Romer v. Evans*, 517 U.S. 620 (1996).

47. *Id.*

48. The Ninth Amendment was James Madison's attempt to ensure that the Bill of Rights was not seen as granting to the people of the United States only the specific rights it addressed — affirming the existence of unenumerated rights. See *THE FEDERALIST* NO. 84 (Modern Library ed. 1937); see also *ANNALS OF CONGRESS* 439 (1789).

49. U.S. CONST. amend. IX.

with the Ninth Amendment's admonition. For example, parents' decisions concerning the "care, custody, and control" of their own children is declared to be a fundamental right.<sup>50</sup> Privacy in marriage and the right to marry has also been declared to be a fundamental right.<sup>51</sup> More recently, the Supreme Court in *Obergefell* held that same-sex couples also have a fundamental right to marry.<sup>52</sup>

With respect to the *Juliana* case posture, it is important to recognize that at the motion to dismiss stage the claims are taken as fact and the court simply questions the legality of those claims.<sup>53</sup> Thus, Judge Aiken's application of strict scrutiny review—as if there were a government infringement on the children's fundamental right—was the appropriate standard.<sup>54</sup> Therefore, as Judge Aiken correctly articulated, the United States' motion to dismiss hinged on whether the plaintiffs have alleged infringement of a fundamental right.<sup>55</sup> The children's due process claim includes both action and inaction allegations against the federal government. Both issues are analyzed separately below.

#### i. Due Process: Fundamental Rights and Government Infringement

The Supreme Court cautions federal courts from breaking new ground in the declaration of fundamental rights.<sup>56</sup> The Court permits, however, that fundamental liberty rights may be expressly enumerated in the Constitution, as (1) "deeply rooted in this Nation's history and tradition," or (2) "fundamental to our scheme of ordered liberty."<sup>57</sup> The Court has also stated that this Nation's founders "entrusted to future generations a charter protecting the right of all persons to enjoy liberty as we learn its meaning."<sup>58</sup> With that, Justice Kennedy admonished that in determining whether a right is fundamental, courts must "exercise reasoned judgment."<sup>59</sup> Thus, Judge Aiken addressed the children's due process claims via her "reasoned judgment," in determining whether a climate system capable of sustaining human life is indeed a fundamental right.<sup>60</sup>

Accordingly, Judge Aiken analyzed the children's lawsuit under the *Obergefell* case precedent. She declared that the children's claim to a fundamental liberty right to a "climate system capable of sustaining human life" parallels *Obergefell's* reasoning because "[j]ust as marriage is the 'foundation of the family,' a stable climate

50. *Troxel v. Granville*, 530 U.S. 57 (2000); *see also* *Pierce v. Soc'y of the Sisters of the Holy Names of Jesus & Mary*, 268 U.S. 510 (1925); *Meyer v. Nebraska*, 262 U.S. 390 (1923).

51. *See Zablocki v. Redhail*, 434 U.S. 374 (1978) (holding that states cannot prohibit people who owe child support from marrying); *Loving v. Virginia*, 388 U.S. 1 (1967) (invalidating law banning interracial marriage and recognizing the "freedom to marry" as a fundamental liberty interest for substantial due process purposes); *Griswold v. Connecticut*, 381 U.S. 479 (1965) (holding that "[r]ights have penumbras, formed by emanations from those guarantees that help give them life and substance"—ultimately leading to the zones-of-privacy framework).

52. *Obergefell v. Hodges*, 135 S. Ct. 2584, 2598 (2015).

53. *Juliana v. United States*, 217 F. Supp. 3d 1224, 1235 (D. Or. 2016).

54. *Id.* at 1248; *see also* *Witt v. Dep't of Air Force*, 527 F.3d 806, 817 (9th Cir. 2008).

55. *Juliana*, 217 F. Supp. 3d at 1249; *see also* *Reno v. Flores*, 507 U.S. 292, 302 (1993).

56. *Obergefell*, 135 S. Ct. at 2598.

57. *McDonald v. City of Chicago*, 561 U.S. 742, 767 (2010) (emphasis omitted from original).

58. *Obergefell*, 135 S. Ct. at 2598.

59. *Id.*

60. *Juliana*, 217 F. Supp. 3d at 1250.

system is quite literally the foundation 'of society, without which there would be neither civilization nor progress.'"<sup>61</sup> Additionally, she confirmed that the children's claim that "a stable climate is a necessary condition to exercising other rights to life, liberty, and property" is wholly consistent with *Obergefell's* reasoning.<sup>62</sup>

Essentially, Judge Aiken's reasoning analogized the unenumerated right to marry (tied to the exercise of the right to privacy) with the children's claim of an unenumerated right to a stable climate system (tied to the exercise of the enumerated rights to life, liberty, and property). Judge Aiken correctly emphasized that when the government recognizes a direct link between climate disturbance and the hindrance of its citizen's health and welfare while knowingly approving and promoting the continuance of the forcing agents (fossil fuels), the principal cause of the climate disturbance, the children's alleged right was infringed and thus due process of law must be afforded.<sup>63</sup> Moreover, because the government is affirmatively and substantially damaging the climate system, and thus infringing upon the children's right to liberty, Judge Aiken was correct to confirm that the children have adequately alleged an infringement of a fundamental right sufficient to be afforded due process.

#### ii. Due Process: Government Inaction and the Danger Creation Exception

The inaction component of the United States' dismissal argument is characterized as a danger creation challenge. Essentially, the "danger creation exception" is an exception to the general rule that the Due Process Clause does not impose an affirmative obligation to act on the government.<sup>64</sup> As Judge Aiken pointed out, the danger creation exception "permits a substantive due process claim when government conduct 'places a person in peril in deliberate indifference to their safety.'"<sup>65</sup> Such indifference must be the product of a "culpable mental state more than gross negligence."<sup>66</sup> To challenge the government on inaction grounds, the children must show: (1) the government's acts created the danger; (2) the government knew its acts caused that danger; and (3) the government, with "*deliberate indifference*," failed to act to prevent the alleged harm.<sup>67</sup>

After taking the necessary steps to analyze the plausibility of the danger creation challenge, Judge Aiken concluded that the government's failure to act in limiting third-party CO<sub>2</sub> emissions enables the children to fall under the danger creation

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61. *Id.* (quoting *Obergefell*, 135 S. Ct. at 2598).

62. *Juliana*, 217 F. Supp. 3d at 1250.

63. *Id.*

64. *Id.* at 1251; *L.W. v. Grubbs*, 974 F.2d 119, 121 (9th Cir. 1992).

65. *Juliana*, 217 F. Supp. 3d at 1251 (internal punctuation omitted) (quoting *Penilla v. City of Huntington Park*, 115 F.3d 707, 709 (9th Cir. 1997)).

66. *Id.* (quoting *Pauluk v. Savage*, 836 F.3d 1117, 1125 (9th Cir. 2016)).

67. *Id.* (emphasis added); see also *Pauluk*, 836 F.3d at 1125; *Campbell v. Wash. Dep't of Soc. & Health Servs.*, 671 F.3d 837, 846 (9th Cir. 2011); *Kennedy v. City of Ridgefield*, 439 F.3d 1055, 1061 (9th Cir. 2006).

exception.<sup>68</sup> If the children could prove their allegations at trial, Judge Aiken affirmed, due process would require government action to reduce emissions under the danger creation exception.<sup>69</sup> That is, the children’s allegation that the United States had full knowledge that it was and is a major contributor to the global climate crisis, and was unreasonable in pursuing the risks, is more than plausible to fit within the danger creation exception.

### B. Public Trust Claim

The Public Trust Doctrine (PTD) predates the Constitution of the United States, tracing back to sixth century Rome. Roman Law proclaimed that “the following things are by natural law common to all—the air, running water, the sea, and consequently the seashore.”<sup>70</sup> The natural law, codified by civil law, was incorporated into English common law.<sup>71</sup> In the early 1800s, the PTD was incorporated into United States jurisprudence.<sup>72</sup> A New Jersey Supreme Court case, *Arnold v. Mundy*, was the first case in which the United States addressed the PTD’s applicability to natural resources in common law.<sup>73</sup> The *Arnold* court paralleled the ancient Roman Law by articulating that public trust assets “remain common to all the citizens . . . and are called common property . . . [including] the air, the running water, and the sea . . . .”<sup>74</sup>

United States common law took decades to develop the depth and breadth of the PTD as it currently stands. In the late 1800s, the Supreme Court in *Stone v. Mississippi* made clear that “no part of [the trust] can be granted away.”<sup>75</sup> About a decade later, the Court held, in *Illinois Central Railroad Company v. Illinois*, that “[t]he state cannot . . . abdicate its trust over property in which the whole people are interested . . . .”<sup>76</sup>

Over time, the PTD developed into a persistent common law doctrine in the United States. As it currently stands, the PTD requires the government to hold in trust certain trust assets for the people, including common pool natural resources (such as air and water), which cannot be granted away or be abdicated from its duty.<sup>77</sup> However, the purview of the PTD, especially as applied to the federal government, has not been fully defined by the courts.

What the Supreme Court has stated more recently, however, is that the PTD is an inherent sovereign power as an attribute of sovereignty.<sup>78</sup> Justice Kennedy, in *Idaho v. Coeur d’Alene Tribe of Idaho*, declared that the PTD developed as “a natural

68. *Juliana*, 217 F. Supp. 3d at 1251.

69. *Id.* at 1251–52.

70. *Juliana*, 217 F. Supp. 3d at 1253 (quoting THE INSTS. OF JUSTINIAN 2.1.1 (J.B. Moyle trans.)).

71. See *Idaho v. Coeur d’Alene Tribe of Idaho*, 521 U.S. 261, 284, (1997); see also Joseph L. Sax, *The Public Trust Doctrine in Natural Resource Law: Effective Judicial Intervention*, 68 MICH. L. REV. 471, 475 (1970) (examining public trust doctrine history in the United States).

72. See *Juliana*, 217 F. Supp. 3d at 1253–54.

73. *Arnold v. Mundy*, 6 N.J.L. 1, 71 (N.J. 1821).

74. *Id.*

75. *Stone v. Mississippi*, 101 U.S. 814, 820 (1879).

76. *Illinois Cent. R.R. Co. v. Illinois*, 146 U.S. 387, 453 (1892).

77. *Juliana*, 217 F. Supp. 3d at 1253–54.

78. See *Idaho v. Coeur d’Alene Tribe of Idaho*, 521 U.S. 261, 286 (1997).

outgrowth of the perceived public character of submerged lands, a perception which underlies and informs the principle that these lands are tied in a unique way to sovereignty”—including the federal government.<sup>79</sup> Moreover, the California Superior Court in the so-called *Mono Lake* case expanded the scope of the PTD beyond the parameters of navigable waters.<sup>80</sup> That is, the *Mono Lake* holding extended the scope to reach non-navigable tributaries that “affect” navigable waters, including water diversions.<sup>81</sup> Additionally, the purpose of the PTD is “coincident with changing public needs,” and must adapt accordingly.<sup>82</sup> In other words, the PTD “change[s] with the felt necessities of the current generation.”<sup>83</sup>

Judge Aiken broke new ground by holding that the PTD was secured by and enforceable through the Due Process Clause of the Fifth Amendment.<sup>84</sup> At the outset of her PTD analysis, Judge Aiken stressed that it is pivotal to recognize that the PTD dictates that an obligor’s fiduciary obligations of the public trust prevent the obligor from depriving future generations of natural resources necessary for their survival.<sup>85</sup> With that, Judge Aiken explained that the obligation of public trust natural resources is implicated where a fiduciary owes a duty to “protect the trust property against damage or destruction.”<sup>86</sup> With respect to natural resources, Judge Aiken continued, the government has a fiduciary duty to protect public trust assets from damage “so that current and future trust beneficiaries will be able to enjoy the benefits of the trust.”<sup>87</sup>

In short, Judge Aiken described that the common law PTD imposes three types of restrictions on the government: (1) the public trust property must be held available for use by the general public; (2) “the property may not be sold;” and (3) the property must be maintained.<sup>88</sup> Judge Aiken explained that the children asserted that the United States violated the first and third restrictions by allowing the depletion and destruction of public trust assets.<sup>89</sup> Therefore, under the first and third prong, Judge Aiken proceeded in her analysis by discussing four challenges put forth by the United States: (1) the scope of public trust assets; (2) the applicability of public trust obligations to the federal government; (3) the displacement of public trust claims by way of congressional acts; and (4) the enforceability of public trust obligations in federal court.<sup>90</sup>

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79. *Id.*

80. See Michael C. Blumm & Thea Schwartz, *Mono Lake and the Evolving Public Trust in Western Water*, 37 ARIZ. L. REV. 701, 708 (1995).

81. *Id.*; see also Nat’l Audubon Soc’y v. Super. Ct. (*Mono Lake*), 658 P.2d 709, 732 (Cal. 1983) (holding that the public trust doctrine offered independent basis for challenging water diversions).

82. Blumm & Schwartz, *supra* note 80, at 709.

83. *Id.*

84. *Juliana*, 217 F. Supp. 3d at 1260.

85. *Id.*

86. *Id.* at 1254 (citing GEORGE G. BOGERT ET AL., *BOGERT’S TRUSTS AND TRUSTEES* § 582 (2016)).

87. *Juliana*, 217 F. Supp. 3d at 1254 (citing MARY C. WOOD, *A NATURE’S TRUST: ENVIRONMENTAL LAW FOR A NEW ECOLOGICAL AGE* 167 (2014)).

88. *Juliana*, 217 F. Supp. 3d at 1254; see also Sax, *supra* note 71, at 477.

89. *Juliana*, 217 F. Supp. 3d at 1254.

90. *Juliana*, 217 F. Supp. 3d at 1254–55.

### i. Scope of Public Trust Assets

On the one hand, the children alleged that the United States violated its duties as trustee by failing to protect the atmosphere.<sup>91</sup> On the other hand, the United States argued that the atmosphere is not a public trust asset.<sup>92</sup> At this juncture, Judge Aiken found it unnecessary to determine whether the atmosphere is a public trust asset because the children had alleged violations of the PTD in connection with other defined assets within the public trust *res*.<sup>93</sup> Moreover, because some of the children's asserted injuries related to other explicitly defined public trust assets, such as ocean acidification and rising ocean levels and temperatures, Judge Aiken concluded that the children had adequately alleged harm to defined public trust assets.<sup>94</sup>

Judge Aiken was correct in her assessment of finding it unnecessary to categorize the atmosphere as a public trust asset, at that point. However, this aspect is crucial to the children's case moving forward. In a recent case, *Foster v. Washington Department of Ecology*, the Washington Superior Court stated, speaking of the younger generations, that their "very survival depends upon the will of their elders to act now, decisively and unequivocally, to stem the tide of global warming . . ." <sup>95</sup> That court went on to emphasize the inextricable relationship between navigable waters and the atmosphere and decided that the separation of the two was "nonsensical."<sup>96</sup> The same logic can be used when analyzing the case at hand. That is, the atmosphere, when viewed in the context of the hydrologic cycle as a whole, reveals an inextricable relationship that places the atmosphere squarely within the scope of public trust assets.

### ii. Applicability of the Public Trust Doctrine to the Federal Government

The United States contended, mainly citing *PPL Montana, LLC v. Montana*, that the PTD applies only to the states and not to the federal government.<sup>97</sup> Judge Aiken rejected the United States' argument by concluding that, because the public trust is an attribute of sovereignty, the PTD is inherently applicable to the federal government.<sup>98</sup> On its face, *PPL Montana* includes wording that seemingly supports the United States' argument—for example, "the public trust doctrine remains a matter of state law."<sup>99</sup> Judge Aiken correctly concluded, however, that although the language is facially consistent with its argument, the United States contextually misread the sentences derived from that case.<sup>100</sup> In *PPL Montana*, that court expressly

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91. *Id.* at 1255.

92. *Id.* at 1254–55.

93. *Juliana*, 217 F. Supp. 3d at 1255.

94. *Id.* at 1255–56; *see also Sax, supra* note 71, at 556 (explaining that public trust law covers "the low-water mark on the margin of the sea . . . and the waters within rivers and streams of any consequence").

95. *Foster v. Wash. Dep't of Ecology*, No. 14-2-25295-1 SEA, 2015 WL 7721362, at \*2 (Wash. Super. Ct. 2015).

96. *Id.* at \*4.

97. *Juliana*, 217 F. Supp. 3d at 1256.

98. *Id.* at 1257.

99. *PPL Montana, LLC v. Montana*, 565 U.S. 576, 603 (2012).

100. *Juliana*, 217 F. Supp. 3d at 1256–59.

declined to address the viability of the federal PTD.<sup>101</sup> Instead, that court examined the imposition of a district court on the federal government after a ruling was made with respect to land being taken pursuant to eminent domain.<sup>102</sup> Thus, the case upon which the United States based its argument concerned a contextually different situation than the case at hand.<sup>103</sup>

Although not directly on-point, Judge Aiken's conclusion that the federal government indeed holds public assets in trust for the people is supported by case law. Judge Aiken examined two federal court cases that have concluded that the PTD applies to the federal government.<sup>104</sup> In one of those cases, the District Court of Massachusetts in *United States v. 1.58 Acres of Land* explicitly held that the federal government is subject to a federal public trust.<sup>105</sup> Additionally, the Ninth Circuit in *United States v. 32.42 Acres of Land* implicated the existence of a federal public trust.<sup>106</sup> Regardless of case precedent, Judge Aiken was correct in concluding that the PTD applies to the federal government because the PTD has a historically unique relationship to sovereignty. Judge Aiken astutely concluded that "[she] can think of no reason why the [PTD], which came to this country through the Roman and English roots of our [legal] system, would apply to the states but not to the federal government."<sup>107</sup>

### iii. Non-Displacement of Public Trust Claims

The United States argued, relying on the Supreme Court case, *American Electric Power Company, Inc. v. Connecticut*, that certain acts of Congress (e.g., the Clean Air Act and Clean Water Act) have displaced common law public trust claims.<sup>108</sup> *American Electric* concerned a nuisance claim that could not proceed because, as the Court held, the "Clean Air Act . . . displace[d] any federal common law right to seek abatement."<sup>109</sup> In particular, the United States focused its argument on the language "any federal common law right."<sup>110</sup> Judge Aiken concluded that in *American Electric* the Court did not have public trust claims before it, so it did not

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101. *PPL Montana, LLC*, 565 U.S. at 603.

102. *Juliana*, 217 F. Supp. 3d at 1257–58.

103. *Id.* at 1257; *see also* *United States v. 32.42 Acres of Land*, 683 F.3d 1030, 1038 (9th Cir. 2012); *see also* *Alec L. ex rel. Loorz v. McCarthy*, 561 F. App'x 7, 8 (D.C. Cir. 2014).

104. *Juliana*, 217 F. Supp. 3d at 1257–58 (examining both *City of Alameda v. Todd Shipyards Corp.*, 632 F. Supp. 1447 (N.D. Cal. 1986) and *United States v. 1.58 Acres of Land*, 523 F. Supp. 120, 124 (D. Mass. 1981)).

105. *See 1.58 Acres of Land.*, 523 F. Supp. at 124 (holding that "since the trust impressed upon this property is governmental and administered jointly by the state and federal governments by virtue of their sovereignty, neither sovereign may alienate this land free and clear of the public trust."); *see also City of Alameda*, 635 F. Supp. at 1447 (holding that "if portion of tidelands area acquired by United States by condemnation was subject to action of tides at time of condemnation, then United States acquired portion subject to public trust, and United States could not convey this portion to private party.").

106. *Juliana*, 217 F. Supp. 3d at 1274.

107. *Id.* at 1259.

108. *Id.*

109. *Am. Elec. Power Co. v. Connecticut*, 564 U.S. 410, 424 (2011).

110. *Juliana*, 217 F. Supp. 3d. at 1259.

consider the differences between public trust claims and other types of claims.<sup>111</sup> Judge Aiken further stated that the public trust claims concern public trusts that “impose[] on the government an obligation to protect the *res* of the trust. . . . [which] cannot be legislated away.”<sup>112</sup> Thus, Judge Aiken correctly concluded that a “displacement analysis simply does not apply.”<sup>113</sup>

Under a displacement analysis, the Supreme Court noted that legislation may only exclude the declaration of federal common law if “the statute ‘speak[s] directly to [the] question at issue.’”<sup>114</sup> But, since the PTD presents a constitutional limit on sovereign authority, there can be no displacement even if Congress were to speak directly to the issue at hand.<sup>115</sup> Thus, the *American Electric* inquiry, which looked simply to what the statute addresses, is inappropriate in a constitutional public trust context.

The United States also argued that the Supreme Court, in *Kleppe v. New Mexico*, stated that “[t]he power over public land entrusted to Congress by the Property Clause of the United States Constitution is ‘without limitations[,]’ which cannot be reconciled.”<sup>116</sup> Judge Aiken explained that the United States again took “the Supreme Court’s statement out of context.”<sup>117</sup> That is, Judge Aiken clarified:

The Supreme Court in *Kleppe* simply did not have before it the question of whether the Constitution grants the federal government unlimited authority to do whatever it wants with any parcel of federal land, regardless of whether its actions violate individual constitutional rights or run afoul of public trust obligations.<sup>118</sup>

Therefore, Judge Aiken correctly reiterated, the United States’ reading is out of context because the context under review is solely within the parameters of the PTD.<sup>119</sup>

#### iv. Enforceability of Public Trust Obligations in Federal Court

The United States’ final contention was that the children lack a cause of action to enforce the public trust claim in federal court.<sup>120</sup> Judge Aiken characterized the “defining feature” of the PTD as the duty to protect the entirety of the *res* of the trust, and a duty which “cannot be legislated away.”<sup>121</sup> Judge Aiken concluded that “public trust rights both predate[] the Constitution and are secured by it.”<sup>122</sup> She

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111. *Id.* at 1260.

112. *Id.*

113. *Id.*

114. *Am. Elec. Power Co.*, 564 U.S. at 424 (quoting *Mobil Oil Corp. v. Higginbotham*, 436 U.S. 618, 625 (1978)).

115. *Juliana*, 217 F. Supp. 3d at 1260.

116. *Id.* at 1259 (quoting *Kleppe v. New Mexico*, 426 U.S. 529, 539 (1976)).

117. *Id.* at 1259.

118. *Id.*

119. *Id.*

120. *Id.* 1260–61.

121. *Juliana*, 217 F. Supp. 3d at 1260.

122. *Id.*; see also Gerald Torres & Nathan Bellinger, *The Public Trust: The Law’s DNA*, 4 WAKE FOREST J.L. & POL’y 281, 288–94 (2014).



also restated that the PTD defines inherent aspects of sovereignty. That is, she explained, citing *Illinois Central*, governments “possess certain powers that permit them to safeguard the rights of the people; these powers are inherent in the authority to govern and cannot be sold or bargained away.”<sup>123</sup>

Judge Aiken explained that the children’s right of action to enforce the government’s obligations as trustee arises, although inherently, from the Constitution through substantive due process claims of the Fifth Amendment.<sup>124</sup> As previously stated, substantive due process “safeguards fundamental rights that are ‘implicit in the concept of ordered liberty’ or ‘deeply rooted in this Nation’s history and tradition.’”<sup>125</sup> Judge Aiken concluded that the public trust, since it is not enumerated in the Constitution, is incorporated in substantive due process protection pursuant to the Ninth Amendment.<sup>126</sup> Therefore, since the children adequately alleged PTD ties to constitutional due process claims, Judge Aiken concluded correctly that the children may assert these claims before a federal court.

#### IV. THE SCIENCE INFORMING THE CHILDREN’S LAWSUIT

As stated in the introduction of this Article, the litigation strategy set forth by the children includes a science-based climate recovery plan designed to reduce atmospheric CO<sub>2</sub> concentrations below 350 ppm by the year 2100.<sup>127</sup> The scientific predictions are based on models interpreted as the “Hansen prescription.”<sup>128</sup> The Hansen prescription represents the “best available science” concerning actions necessary to avert climate catastrophe.<sup>129</sup>

Professor James Hansen, former head of NASA’s Goddard Institute for Space Studies and professor at Columbia University’s Earth Institute, formed an international team of scientists to research the connection among atmospheric CO<sub>2</sub> concentrations and global temperature and set out to provide model projections based on that research.<sup>130</sup> The Hansen team is a counterpart to the concurrent science produced by the United Nations Intergovernmental Panel on Climate Change (IPCC).<sup>131</sup> In its Fifth Assessment in 2014, the IPCC Working Group concluded that

123. *Juliana*, 217 F. Supp. 3d at 1261 (citing *Illinois Cent. R.R. Co. v. Illinois*, 146 U.S. 387, 459–60 (1892)).

124. *Id.*

125. *Id.* (quoting *McDonald v. City of Chicago*, 561 U.S. 742, 761, 767 (2010)).

126. *Juliana*, 217 F. Supp. 3d at 1261; *see also* *Raich v. Gonzales*, 500 F.3d 850, 861–66 (9th Cir. 2007).

127. *See generally Juliana*, 217 F. Supp. 3d at 1224.

128. *See* Michael C. Blumm & Mary C. Wood, “No Ordinary Lawsuit”: *Climate Change, Due Process, and the Public Trust Doctrine*, 67 AM. U. L. REV. 1, 16–17 (2017).

129. *Id.* at 16.

130. Suzanne Goldenberg, *UN’s 2C Target Will Fail to Avoid a Climate Disaster, Scientists Warn*, *GUARDIAN* (Dec. 3, 2013, 6:28 PM), <https://www.theguardian.com/environment/2013/dec/03/un-2c-global-warming-climate-change>.

131. Dana Nuccitelli, *30 Years Later, Deniers are Still Lying About Hansen’s Amazing Global Warming Prediction*, *GUARDIAN* (June 25, 2018), <https://www.theguardian.com/environment/climate-consensus-97-per-cent/2018/jun/25/30-years-later-deniers-are-still-lying-about-hansens-amazing-global-warming-prediction>.

without efforts to reduce anthropogenic greenhouse gas emissions, atmospheric concentrations will at their baseline exceed 850 ppm by 2100.<sup>132</sup> In turn, the IPCC projected that such CO<sub>2</sub> levels implicate an increase of global temperature well above the threshold sufficient to initiate a runaway greenhouse effect.<sup>133</sup>

While the IPCC focused on the overall temperature increase—applying a stringent mitigation scenario to keep warming under two degrees Celsius—the Hansen team took a slightly different approach.<sup>134</sup> The Hansen team focused on exploring the connection among atmospheric CO<sub>2</sub> concentrations and the stable state of Earth’s energy.<sup>135</sup> The Hansen team likewise concluded that the global climate is reaching a dangerous ecological threshold, which, if reached, will trigger positive feedback processes that will unleash an irreversible heating trend capable of shifting the balance of Earth’s climate system to a state uninhabitable by humans.<sup>136</sup>

#### A. What are Greenhouse Gases and the Greenhouse Effect?

A basic distinction when studying the science of Earth’s climate is the difference between the following terms: greenhouse effect, global warming, and climate change. Greenhouse gasses are a class of gasses that trap heat near the Earth’s surface.<sup>137</sup> The heat that is trapped leads to global warming; global warming alters the Earth’s climate system, which leads to climate change.<sup>138</sup> The greenhouse effect, although largely enhanced by humans, is a natural process that allows for temperatures favorable for life on Earth to exist.<sup>139</sup> In the absence of this process, the estimated average temperature of the Earth would be -18° Celsius—also making Earth uninhabitable by humans.<sup>140</sup>

Earth’s lower atmosphere is comprised of approximately 78% nitrogen, 21% oxygen, and 1% of other gases—of which CO<sub>2</sub> accounts for 0.04%.<sup>141</sup> CO<sub>2</sub> is the most prevalent greenhouse gas concentrated in the Earth’s atmosphere.<sup>142</sup> The second

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132. See IPCC, CLIMATE CHANGE 2014 SYNTHESIS REPORT SUMMARY FOR POLICYMAKERS (2014), [https://www.ipcc.ch/pdf/assessment-report/ar5/syr/AR5\\_SYR\\_FINAL\\_SPM.pdf](https://www.ipcc.ch/pdf/assessment-report/ar5/syr/AR5_SYR_FINAL_SPM.pdf).

133. *Id.*

134. *Id.*

135. See Hansen, *supra* note 20, at 8.

136. *Id.* Current models suggest that global warming would fall outside human safety margins long before any runaway transition would occur because humid conditions hotter than 35° Celsius would make the planet uninhabitable because warm-blooded metabolisms produce more heat than can be dissipated into the surrounding air. See Lee Billings, *Fact or Fiction?: We Can Push the Planet into a Runaway Greenhouse Apocalypse*, *Sci. AM.* (July 13, 2013), <https://www.scientificamerican.com/article/fact-or-fiction-runaway-greenhouse/>.

137. See Philip Camill, *Global Change: An Overview*, NAT’L EDUC. KNOWLEDGE, <https://www.nature.com/scitable/knowledge/library/global-change-an-overview-13255365> (last visited Nov. 11, 2018).

138. *Id.*

139. *Id.*

140. See Q. Ma & R.H. Tipping, *The Distribution of Density Matrices Over Potential-Energy Surfaces: Application to the Calculation of the Far-Wing Line Shapes for CO<sub>2</sub>*, 108 *J. CHEM. PHYS.* 3386 (1998); see also Qiancheng Ma, *Greenhouse Gases: Refining the Role of Carbon Dioxide*, NASA (1998), [https://www.giss.nasa.gov/research/briefs/ma\\_01/](https://www.giss.nasa.gov/research/briefs/ma_01/).

141. Anne Helmenstine, *The Chemical Composition of Air*, THOUGHT CO., <https://www.thoughtco.com/chemical-composition-of-air-604288> (last updated Sep. 21, 2018).

142. *Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2016*, EPA (Apr. 12, 2018), [https://www.epa.gov/sites/production/files/2018-01/documents/2018\\_complete\\_report.pdf](https://www.epa.gov/sites/production/files/2018-01/documents/2018_complete_report.pdf).

most prevalent greenhouse gas, methane, is the most impactful in atmospheric heat retention, causing approximately 15% of all global warming experienced this century.<sup>143</sup> Next, nitrous oxide (laughing gas) is a greenhouse gas that traps heat 270 times more efficiently than CO<sub>2</sub>.<sup>144</sup> What is more, this gas has increased in concentration by more than 20% since the Industrial Revolution.<sup>145</sup> Last, the manmade HFC and CFC family of chemicals, brought into existence by industrial chemists, are also notable greenhouse gases residing in the atmosphere.<sup>146</sup>

While there are numerous greenhouse gasses located in the atmosphere, scientists normalize to CO<sub>2</sub>, or calculate to the CO<sub>2</sub> equivalent.<sup>147</sup> In other words, they calculate the other greenhouse gas contributions to a CO<sub>2</sub> equivalent so it can be expressed as one number. Thus, scientists will calculate a gas like methane, which has twenty-five times the warming potential of CO<sub>2</sub>, by multiplying a unit of methane by twenty-five to reach the CO<sub>2</sub> equivalent.<sup>148</sup>

CO<sub>2</sub> is a byproduct brought about by the burning of fossil fuels.<sup>149</sup> Fossil fuels are often described as buried or fossilized sunshine.<sup>150</sup> That is, fossil fuels are the fossilized remains of ancient plant communities, which grew in swamps and wetlands, that produced the deposits that are now used by humans for energy—namely, coal, oil, and gas.<sup>151</sup> Out of the commonly used fossil fuels, coal produces the most CO<sub>2</sub> per unit burned.<sup>152</sup> Broken down to atmospheric CO<sub>2</sub> ppm concentrations, coal contributes to 41%, oil to 39%, and gas to 20%.<sup>153</sup> In perspective, burning one gallon of gasoline is equivalent to a forest fire burning 196,000 pounds of plant biomass.<sup>154</sup>

The sun, aside from being the creator of fossil fuels, is also the main driver of climate. “Sunlight intensity affects global winds, precipitation patterns, and ocean

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143. *Id.*; see also *Greenhouse Gas Emissions: Overview of Greenhouse Gases*, EPA, <https://www.epa.gov/ghgemissions/overview-greenhouse-gases> (last visited Mar. 20, 2019).

144. See *Greenhouse Gas Emissions: Understanding Global Warming Potentials*, EPA, <https://www.epa.gov/ghgemissions/understanding-global-warming-potentials> (last visited Mar. 20, 2019).

145. *Id.*

146. See *Chlorofluorocarbons (CFCs) and Hydrofluorocarbons (HFCs)*, MINN. POLLUTION CONTROL AGENCY, <https://www.pca.state.mn.us/air/chlorofluorocarbons-cfcs-and-hydrofluorocarbons-hfcs> (last visited Mar. 20, 2019). In addition to contributing to the warming of the lower atmosphere, Hydrofluorocarbons (HFCs) and Chlorofluorocarbons (CFCs) destroy the earth's protective ozone layer, which shields the earth from ultraviolet (UV-B) rays generated from the sun. *Id.*

147. Zeke Hausfather, *Understanding Carbon Dioxide Equivalence: Common Climate Misconceptions*, YALE CLIMATE CONNECTIONS (Jan. 20, 2009), <https://www.yaleclimateconnections.org/2009/01/common-climate-misconceptions-co-equivalence/>.

148. *Id.*

149. *Id.*

150. See TIM FLANNERY, *THE WEATHER MAKERS* 61 (2006).

151. *Id.*

152. *Id.* at 4.

153. See FLANNERY, *supra* note 150, at 277.

154. See Jeff Dukes, *Bad Mileage: 98 Tons Plants per Gallon*, UNIV. OF UTAH NEWS CTR.: SCI. & TECH. (Oct. 27, 2003), [https://archive.uneu.utah.edu/news\\_releases/bad-mileage-98-tons-of-plants-per-gallon/](https://archive.uneu.utah.edu/news_releases/bad-mileage-98-tons-of-plants-per-gallon/).

circulation".<sup>155</sup> This natural cycle exchanges CO<sub>2</sub> from the atmosphere to a draw-down into land biomasses as well as a drawdown into the world's oceans.<sup>156</sup> The oceans are all connected, and the surface currents are connected to the ocean depths, drawing CO<sub>2</sub> into natural sink deposits in a conveyor belt-like system.<sup>157</sup> As the oceans get warmer (and they are indeed getting warmer, as explained below), their capacity to absorb CO<sub>2</sub> is reduced.<sup>158</sup> In turn, ocean currents redistribute the net heat increase, along with moisture and CO<sub>2</sub>, back into the atmosphere and across the surface of the Earth at a higher rate and greater intensity—altering global and regional climate patterns.<sup>159</sup>

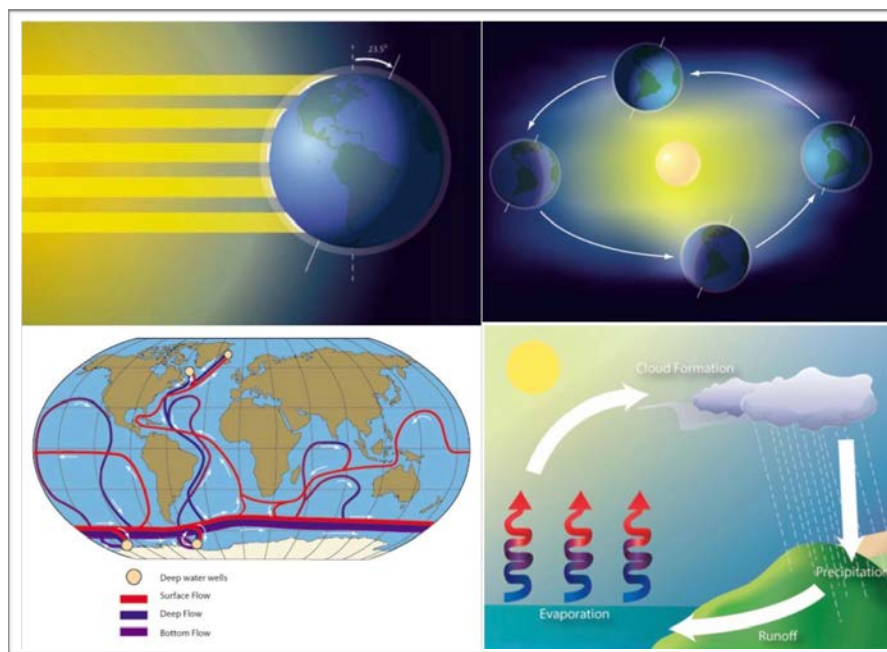


Figure 1:1. The top two pictures show the Earth's relationship with the sun—the Earth's only external source of energy.<sup>160</sup> The bottom-left picture shows the

155. See Alison N.P. Stevens, *Introduction to the Basic Drivers of Climate*, NATURE EDUC. KNOWLEDGE (2010), <https://www.nature.com/scitable/knowledge/library/introduction-to-the-basic-drivers-of-climate-13368032>; Figure 1:1.

156. See Vic DiVenere, *The Carbon Cycle and Earth's Climate*, COLUM. UNIV., <http://www.columbia.edu/~vjd1/carbon.htm> (last visited Mar. 20, 2019); see also I.C. Prentice, et. al., *The Carbon Cycle and Atmospheric Carbon Dioxide*, IPCC (2001), <https://www.ipcc.ch/ipccreports/tar/wg1/pdf/TAR-03.PDF>.

157. See Holli Riebeek, *The Ocean's Carbon Balance*, NASA: EARTH OBSERVATORY (July 1, 2008), <https://earthobservatory.nasa.gov/Features/OceanCarbon/>.

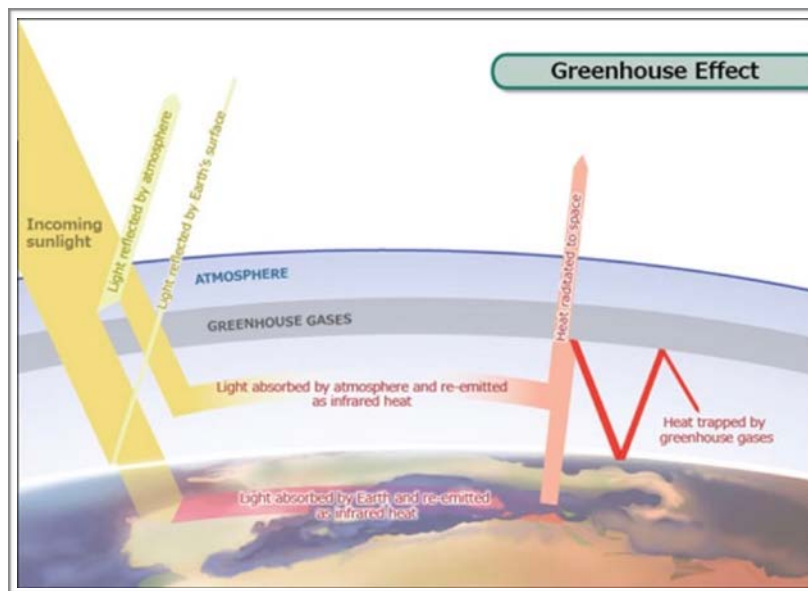
158. *Id.*

159. *Id.*; see also Stevens, *supra* note 155.

160. See Stevens, *supra* note 155.

stratified levels of ocean currents, which, in turn, affect atmospheric wind patterns.<sup>161</sup> The bottom-right picture shows precipitation patterns in connection with the oceans and atmospheric winds.<sup>162</sup>

It is understood by the relevant scientific community that when CO<sub>2</sub> is increased by human activities, mostly through the burning of coal and other fossil fuels, the atmosphere increases its CO<sub>2</sub> concentration.<sup>163</sup> This reduces the heat radiation that returns back to space—creating a temporary heat energy imbalance.<sup>164</sup> When heat is trapped from being released into outer space, a greenhouse effect takes place extending heat to the polar regions of the Earth.<sup>165</sup> Essentially, the greenhouse effect is the trapping of infrared radiation from being released back into space because of the blockage caused by greenhouse gases residing in the lower atmosphere.<sup>166</sup>



161. *Id.*

162. *Id.*

163. *Global Warming FAQ*, UNION OF CONCERNED SCIENTISTS, <https://www.ucsusa.org/global-warming/science-and-impacts/science/global-warming-faq.html#.W-jQDvZIDb0> (last visited Mar. 20, 2019).

164. See Michon Scott & Rebecca Lindsey, *Which Emits More Carbon Dioxide: Volcanoes or Human Activities?*, CLIMATE.GOV (June 15, 2016), <https://www.climate.gov/news-features/climate-qa/which-emits-more-carbon-dioxide-volcanoes-or-human-activities>.

165. See Philip Camill, *Global Change: An Overview*, NATURE EDUC. KNOWLEDGE PROJECT (2010), <https://www.nature.com/scitable/knowledge/library/global-change-an-overview-13255365>.

166. See *infra* Figure 1:2.

*Figure 1:2.* A figure showing the greenhouse effect.<sup>167</sup> Focus on the infrared heat being trapped by greenhouse gases (located on the middle-right side of the figure).<sup>168</sup>

The Earth's temperature goes up when greenhouse gas concentrations are increased because the sun's rays (comprised of photons) excite the state of CO<sub>2</sub>, which then causes expansion of the molecules and, in turn, causes the reflection of infrared energy back to the Earth's surface.<sup>169</sup> In other words, to the visible light from the sun, CO<sub>2</sub> is a transparent gas. But to the infrared energy emanating from the ground up, CO<sub>2</sub> is not so transparent. Thus, infrared energy is re-radiated back to Earth, which then increases Earth's overall heat energy.<sup>170</sup> Scientists look to human-induced fossil fuel emissions as the primary source of CO<sub>2</sub> because it is calculated that humans emit roughly forty billion metric tons of CO<sub>2</sub> per year.<sup>171</sup> In perspective, that is over sixty times the amount of CO<sub>2</sub> released by natural processes each year.<sup>172</sup> Moreover, the total human emission equals more than 2,000 billion metric tons of CO<sub>2</sub> since the Industrial Revolution.<sup>173</sup> The emissions mainly show up in our economy, in sectors such as electricity energy, land-use, transportation, and etcetera.<sup>174</sup>

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167. Edward B. Mondor & Michelle N. Tremblay, *Global Atmospheric Change and Animal Populations*, NATURE EDUC. KNOWLEDGE PROJECT (2010), <https://www.nature.com/scitable/knowledge/library/global-atmospheric-change-and-animal-populations-13254648>.

168. *Id.*

169. *Id.*

170. See Pieter Tans, *If Carbon Dioxide Makes up Only a Minute Portion of the Atmosphere, How Can Global Warming Be Traced to It? And How Can Such a Tiny Amount of Change Produce Such Large Effects?*, SCI. AM. (Jul. 24, 2006), <https://www.scientificamerican.com/article/if-carbon-dioxide-makes-u/>.

171. *Global Greenhouse Gas Emissions Data*, EPA (Apr. 13, 2017), <https://www.epa.gov/ghgemissions/global-greenhouse-gas-emissions-data>; see *infra* Figure 1:3.

172. See Michon Scott & Rebecca Lindsey, *Which Emits More Carbon Dioxide: Volcanoes or Human Activities?*, CLIMATE.GOV (June 15, 2016), <https://www.climate.gov/news-features/climate-qa/which-emits-more-carbon-dioxide-volcanoes-or-human-activities>.

173. *Id.*; see also Michael Beman, *Energy Economics in Ecosystems*, NATURE EDUC. KNOWLEDGE PROJECT (2010), <https://www.nature.com/scitable/knowledge/library/energy-economics-in-ecosystems-13254442>.

174. *Global Greenhouse Gas Emissions Data*, EPA (2018), <https://www.epa.gov/ghgemissions/global-greenhouse-gas-emissions-data>; see *infra* Figure 1:4.

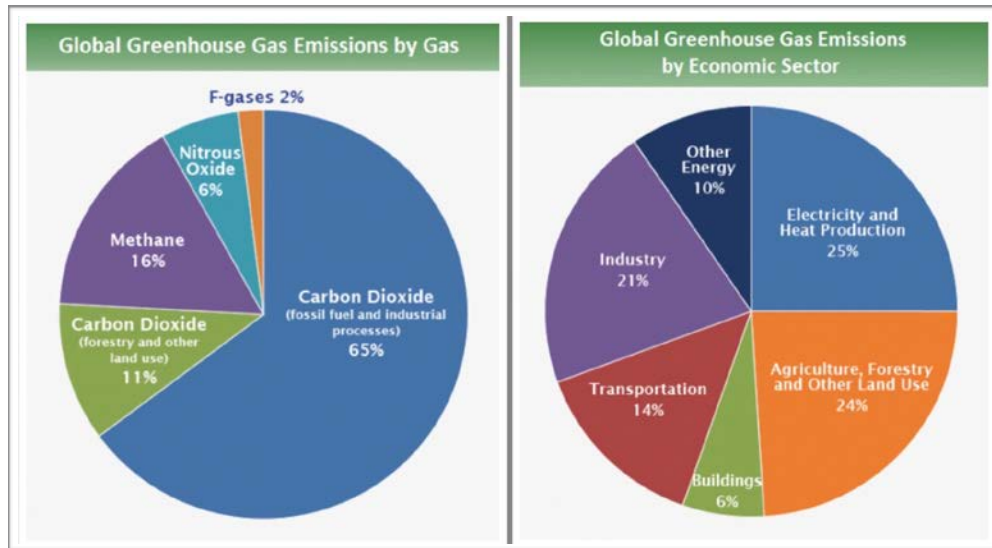


Figure 1:3. (left) Graph showing CO<sub>2</sub> as the majority Greenhouse Gas emitted.<sup>175</sup>

Figure 1:4. (right) Graph showing GHG emissions by economic sector.<sup>176</sup>

#### B. What are Positive Feedbacks and How Does that Exacerbate the Problem?

Rapid global warming is due mainly to the greenhouse effect caused by human-induced greenhouse gas emissions into the atmosphere.<sup>177</sup> The Tropopause portion of the atmosphere, located approximately seven miles above Earth's surface, is where most of the greenhouse gasses reside.<sup>178</sup> The Tropopause is also where much of Earth's weather is generated.<sup>179</sup> Global warming intensifies the Tropopause and spreads the heat to the poles, which proliferates the melting of polar ice sheets and makes the planet darker, so it absorbs more sunlight and becomes even warmer.<sup>180</sup> The warmer oceans release more CO<sub>2</sub>, and more CO<sub>2</sub> causes

175. *Id.*

176. *Id.*

177. Facts, NASA, <https://climate.nasa.gov/causes/> (last visited Mar. 20, 2019).

178. See Davide Castelvetti, *With One Space Observatory Down, NASA Uses Another to Map CO<sub>2</sub>*, SCI. AM. (Dec. 17, 2009), <https://www.scientificamerican.com/article/space-observatory-co2-nasa/>; see generally *Tropopause*, ENCYCLOPEDIA BRITANNICA, <https://www.britannica.com/science/tropopause> (last visited Mar. 20, 2019).

179. See Castelvetti, *supra* note 178. See generally Mark E. Piana, *Hadley Cells*, SEAS HARV. EDU., <https://www.seas.harvard.edu/climate/eli/research/equable/hadley.html> (last visited Mar. 20, 2019) ("Hadley Cells are low-latitude overturning circulations that have air rising at the equator and air sinking at roughly 30° latitude. They are responsible for the trade winds in the Tropics and control low-latitude weather patterns.")

180. See FLANNERY, *supra* note 150, at 26.

more warming.<sup>181</sup> But, because the climate system has great inertia, there is a lag in the effects experienced in real time.<sup>182</sup> Because ice is reflective, a large proportion of the sunlight that hits the ice is bounced back to space, which limits the amount of warming it causes—characterized as the Albedo Effect.<sup>183</sup> Fresh snow and ice reflects around 80% of heat energy out into space, while water only reflects around 8%.<sup>184</sup> “As the [Earth] gets [warmer], ice melts, revealing the darker-colored land or water below. The result is that more of the sun’s energy is absorbed, leading to more warming, which in turn leads to more ice melting—and so on.”<sup>185</sup>

This phenomenon is characterized as a positive feedback loop.<sup>186</sup> Occurring within this loop, CO<sub>2</sub> acts as a “trigger” for water vapor due to the fact that warmer air masses are capable of holding more water than cooler ones.<sup>187</sup> CO<sub>2</sub> acts as a trigger by allowing the atmosphere to heat up through radiation, allowing it to retain more moisture, which then warms the atmosphere further.<sup>188</sup> The heat energy derived from evaporation carries a large amount of water vapor into the atmosphere.<sup>189</sup> This latent heat of water produces hurricane formations because the latent heat is liberated when massive quantities of water vapor rapidly condense.<sup>190</sup> As a result, hurricanes and other weather-related disasters cause extraordinary costs to the human population worldwide.<sup>191</sup>

It has been calculated that 90% of this additional heat energy is absorbed by the oceans.<sup>192</sup> When the oceans absorb this excess heat, it becomes increasingly more difficult for winds to mix the surface layers with the deeper layers—so the oceans settle into layers, or stratify.<sup>193</sup> Without an infusion of fresh carbonate-rich

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181. *Id.*

182. See Hansen et al., *supra* note 20, at 1.

183. See FLANNERY, *supra* note 150, at 26 (albedo is Latin for whiteness).

184. See *Cryosphere: Earth’s Frozen Assets*, NASA, [https://www.nasa.gov/centers/goddard/earthandsun/climate\\_change.html](https://www.nasa.gov/centers/goddard/earthandsun/climate_change.html) (last visited Mar. 20, 2019); see also FLANNERY, *supra* note 150, at 26.

185. See *What Are Climate Change Feedback Loops?*, GUARDIAN, <https://www.theguardian.com/environment/2011/jan/05/climate-change-feedback-loops> (last updated Jan. 5, 2011).

186. *Id.*

187. See FLANNERY, *supra* note 150, at 28.

188. *Id.*

189. *Id.*

190. *Id.*

In the wake of hurricanes come floods, and in the wake of floods comes plagues. Cholera breeds in stagnant and polluted water, and mosquitoes that can spread malaria, yellow fever, dengue fever, and encephalitis proliferate. Plague can benefit from the disturbance as fleas, rats, and humans are brought into close proximity as they crowd together on higher ground.

*Id.* at 50.

191. See Stephen Leahy, *Hidden Costs of Climate Change Running Hundreds of Billions a Year*, NAT’L GEOGRAPHIC (Sept. 27, 2017), <https://news.nationalgeographic.com/2017/09/climate-change-costs-us-economy-billions-report/> (explaining that 2017 was the most expensive year on record for natural disasters in the United States—\$306 billion).

192. See LuAnn Dahlman, *Climate Change: Ocean Heat Content*, CLIMATE.GOV (Aug. 1, 2018), <https://www.climate.gov/news-features/understanding-climate/climate-change-ocean-heat-content>.

193. See John Abraham, *Scientists Study Ocean Absorption of Human Carbon Pollution: Knowing the Rate at Which the Oceans Absorb Carbon Pollution is a Key to Understanding How Fast Climate Change Will Occur*, GUARDIAN (Feb. 16, 2017), <https://www.theguardian.com/environment/climate-consensus-97-per-cent/2017/feb/16/scientists-study-ocean-absorption-of-human-carbon-pollution>.



water from below, the surface water saturates with CO<sub>2</sub>.<sup>194</sup> This stagnant water also supports fewer phytoplankton, so CO<sub>2</sub> uptake from photosynthesis slows.<sup>195</sup> In short, “stratification cuts down the amount of CO<sub>2</sub> the ocean can take up.”<sup>196</sup> That is, the increase of oceanic CO<sub>2</sub> is reducing the amount of carbonate in the world’s oceans, and, as the oceans become more acidic, the ocean loses its ability to hold as much CO<sub>2</sub>—which is then transferred back into the atmosphere.<sup>197</sup> Thus, because it is unequivocal that the atmosphere and climate are inextricably entwined with the oceans, the Hansen team concentrated their research primarily on measuring Earth’s oceans.

### C. How Did the Hansen Team Arrive at the 350 ppm Number?

Since over 90% of the extra heat ends up in the oceans, the Hansen team concluded that the most important measurements of global warming must be made in the oceans.<sup>198</sup> Thus, the Hansen team focused their research on a quantitative assessment in measuring Earth’s energy imbalance by measuring the heat content of the Earth’s largest heat reservoirs—the oceans.<sup>199</sup> Specifically, the Hansen team measured, via satellite and Google technology, the chemical composition and heat of the Earth’s oceans by setting up thousands of “Argo floats,” distributed in scattered locations around the globe (see Figure 1:5).<sup>200</sup> In short, these Argo Floats revealed that the upper half of the ocean is gaining heat at a substantial rate caused by absorbing more than 90% of the excess heat energy generated by fossil fuel consumption.<sup>201</sup>

Due to the redundancy in testing and the high accuracy in gauging temperature and identifying chemical composition, the experimentation resulted in high confidence science. A source of uncertainty, however, was instrumental in nature, relating to the measurement process and methodological choices, including gaps in sampling and data coverage.<sup>202</sup> However, in the past decade, improvements have

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194. *Id.* Carbonate is used in the names of some substances that are formed from carbonic acid, which is a compound of carbon dioxide and water. See *Carbonic Acid and Carbonate Salts*, ENCYCLOPEDIA BRITANNICA, <https://www.britannica.com/science/oxyacid/Carbonic-acid-and-carbonate-salts> (last visited Mar. 20, 2019).

195. See Riebeek, *supra* note 157.

196. *Id.*

197. *Id.*

198. Hansen et al., *supra* note 20, at 8.

199. *Id.*; see also John Abraham, *Earth’s Oceans Are Warming 13% Faster Than Thought, and Accelerating*, GUARDIAN (Mar. 10, 2017), <https://www.theguardian.com/environment/climate-consensus-97-per-cent/2017/mar/10/earths-oceans-are-warming-13-faster-than-thought-and-accelerating>.

200. Hansen et al., *supra* note 20, at 8. To track the Argo floats in real time, see *Argo: Part of the Integrated Global Observation Strategy*, ARGO.UCSD.EDU, <http://www.argo.ucsd.edu> (last updated July 9, 2018).

201. See Hansen et al., *supra* note 20, at 8–9; see also *Latest Ocean Warming Review Reveals Extent of Impacts on Nature and Humans*, INT’L UNION FOR CONSERVATION OF NATURE (Sept. 5, 2016), <https://www.iucn.org/news/secretariat/201609/latest-ocean-warming-review-reveals-extent-impacts-nature-and-humans>.

202. Hansen et al., *supra* note 20, at 8.

been made to reduce the sampling errors by using various methodologies.<sup>203</sup> Today, coverage has now reached over 90% of the world's oceans—reaching depths of over a mile (thus covering the majority of the ocean depths)—ensuring data accuracy, and reduction in systematic measurement errors.<sup>204</sup>

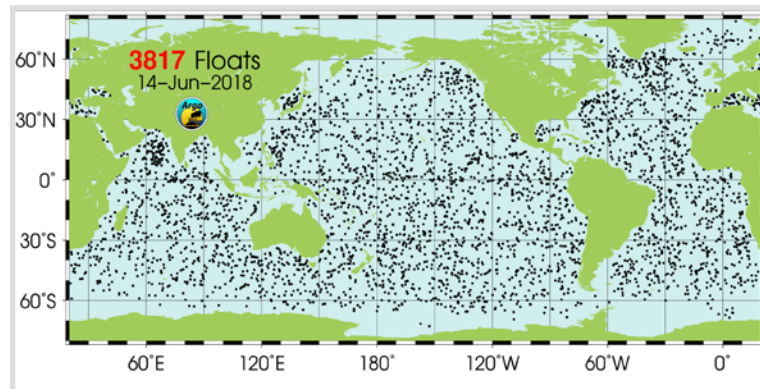


Figure 1:5. Picture shows the placements of 3817 Argo Floats as of June 14, 2018.<sup>205</sup>

The Hansen team sought to eliminate another source of uncertainty by examining whether the sun's intensity, or any other possible heat variable, is causing the acceleration of Earth's temperature increase.<sup>206</sup> The Hansen team used a process of elimination by combining the known variables of heat sources and reducing them to a single variable.<sup>207</sup> These known variables include a set of cycles called Milankovich cycles.<sup>208</sup> One cycle includes the Earth's ellipse around the sun, which changes on a 100,000-year cycle, known as Earth's eccentricity.<sup>209</sup> Another cycle, every 41,000 years, is caused by the tilt of the Earth on its axis.<sup>210</sup> The third cycle, every 19,000-23,000 years, is caused by the wobble of the Earth on its axis.<sup>211</sup>

Coupled with the data produced by the IPCC, the Hansen team's research produced results of high confidence within the climate science field. The Hansen team

203. Lijing Cheng et. al., *Improved Estimates of Ocean Heat Content from 1960 to 2015*, *Sci. ADVANCES* (Mar. 10, 2017), <http://advances.sciencemag.org/content/3/3/e1601545.full>.

204. *See id.*

205. *See Argo*, *supra* note 200.

206. James Hansen et. al., *Young People's Burden: Requirement of Negative CO<sub>2</sub> Emissions*, *EARTH SYS. DYNAMICS DISCUSSIONS* (Oct. 4, 2016), <https://www.earth-syst-dynam-discuss.net/esd-2016-42/esd-2016-42.pdf> (referencing, *inter alia*, the insignificant effects of solar cycle influence, El Niño/La Niña oscillations, and other feedback phenomenon on observed global warming since the Industrial Revolution).

207. *Id.*

208. *See* Christopher J. Campisano, *Milankovitch Cycles, Paleoclimatic Change, and Hominin Evolution*, *NATURE EDUC. KNOWLEDGE PROJECT* (2012), <https://www.nature.com/scitable/knowledge/library/milankovitch-cycles-paleoclimatic-change-and-hominin-evolution-68244581> (last visited Mar. 20, 2019).

209. *Id.*

210. *Id.*

211. *Id.*

uncovered that the measured energy imbalance occurred “during the strongest solar minimum on record”<sup>212</sup>—meaning that the sun’s energy reaching the Earth is at its least powerful.<sup>213</sup> So, since there is more energy staying in than going out, the Hansen team safely inferred that the effect of the sun’s variation on climate is being overwhelmed by an alternative heating source.<sup>214</sup>

In addition to confirming what has already been long documented—that CO<sub>2</sub> concentration levels and the heat of the Earth are inextricably entwined—the Hansen team observed that the linear growth of temperature is reached after an exponential growth of atmospheric CO<sub>2</sub> heat-absorption.<sup>215</sup> Simply put, CO<sub>2</sub> warms the climate logarithmically due to the positive feedback loop process.<sup>216</sup> So, for the Hansen team to accurately measure the stable state of climate equilibria, they were left with formulating logarithmic calculations to measure climate inertia and thus pinpoint the heat energy at which the climate system reaches a stable state.<sup>217</sup>

These calculations led the Hansen team to conclude that Earth is out of energy balance by ~0.5 W/m<sup>2</sup>.<sup>218</sup> The Hansen team explained that ~0.5 W/m<sup>2</sup>, although a seemingly insignificant figure on its face, is equivalent to over 400,000 Hiroshima atomic bombs exploding each day—every day of the year.<sup>219</sup> In turn, the heat energy imbalance calculations enabled the Hansen team to accurately deduce how much CO<sub>2</sub> must be reduced to restore energy balance to reach a stabilized climate system.<sup>220</sup> Moreover, the Hansen team, through the use of climate models, determined that 350 ppm is the level of atmospheric CO<sub>2</sub> at which equilibrium may be reached.<sup>221</sup>

From there, the Hansen team prescribed what is mathematically necessary to return to equilibrium at 350 ppm.<sup>222</sup> That is, assuming all other nations commit to the COP23 agreements and no abnormal shocks are entered into the system, and that the United States phases out fossil fuel consumption at a rate of 8% per year starting in 2017 and implements either a geo-engineering approach or a more plausible reforestation approach; then atmospheric CO<sub>2</sub> concentrations may reach 350 ppm by the year 2100 (see Table 1:1).<sup>223</sup>

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212. Hansen et al., *supra* note 20, at 9.

213. See Tony Phillips, *Deep Solar Minimum*, NASA: SCIENCE BETA (Apr. 1, 2009), [https://science.nasa.gov/science-news/science-at-nasa/2009/01apr\\_deepsolarminimum](https://science.nasa.gov/science-news/science-at-nasa/2009/01apr_deepsolarminimum).

214. Hansen et al., *supra* note 20, at 15.

215. *Id.*

216. *Id.* at 13.

217. See generally *id.* at 14.

218. See generally *id.* at 15. W/m<sup>2</sup> stands for watts per square meter.

219. James Hansen, *Why I Must Speak Out About Climate Change*, TED TALK (Feb. 2012), [https://www.ted.com/talks/james\\_hansen\\_why\\_i\\_must\\_speak\\_out\\_about\\_climate\\_change](https://www.ted.com/talks/james_hansen_why_i_must_speak_out_about_climate_change).

220. James Hansen et al., *Earth's Energy Imbalance*, NASA (Jan. 2012), [https://www.giss.nasa.gov/research/briefs/hansen\\_16/](https://www.giss.nasa.gov/research/briefs/hansen_16/).

221. Hansen et al., *supra* note 20, at 9.

222. *Id.*

223. Hansen et al., *supra* note 20, at 12. COP23 was organized by Climate Action, UN Environment, and UNFCCC which took place in 2015 in Bonn, Germany. See *COP23 Bonn Germany: Sustainable Innovation Forum 2017*, U.N., <http://www.cop-23.org/> (last visited Mar. 20, 2019). This event included governments,

Essentially, the Hansen team’s graph simulates the way the atmosphere is behaving and provides mathematically-based predictions that indicate how it will behave in the future. In other words, the graph represents the current trend of CO<sub>2</sub> ppm concentrations in the atmosphere and predicts future CO<sub>2</sub> reduction based on strict conformity to the Hansen team’s climate recovery plan. The Hansen team’s figure also shows that the course of climate change is set for the next few decades—regardless of what action is taken—because the greenhouse gases are already in the atmosphere, with a lag in effect. And, right now, there is no viable means of getting it out.<sup>224</sup> This means that the course of climate change is set for at least the next several decades.<sup>225</sup> More specifically, the full impact of the greenhouse gases already in the atmosphere will not be experienced until around 2050.<sup>226</sup> Because we lack an economically efficient way to capture greenhouse gases out of the atmosphere, this decades-long period of lag is considered a true physical commitment due to the long life of CO<sub>2</sub> in the atmosphere.<sup>227</sup>

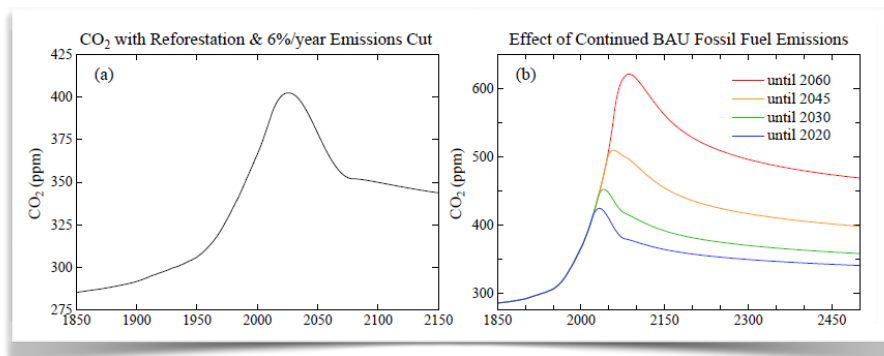


Table 1:1. Projected CO<sub>2</sub> reduction rate to reach 350 ppm by 2100.

*Note:* The Hansen team explained that this graph shows that if global CO<sub>2</sub> emissions peak and reductions begin in 2017, the annual rate of reduction will be 8% per year alongside 100 GtC (gigatons of carbon) of global reforestation throughout the century.<sup>228</sup> However, if emission reductions do not begin until 2020, a 15% per year reduction rate will be required to reach 350 ppm by 2100.<sup>229</sup> If reductions are delayed beyond 2020, it might not be possible to return to 350 ppm until well after 2500.<sup>230</sup>

cities, and regions from the 152 countries that have ratified the Paris Agreement, which agreed that they must now meet their national climate change commitments. *See id.*

224. *See* Peter Wadhams, *Saving the World with Carbon Dioxide Removal*, WASH. POST (Jan. 8, 2018), [https://www.washingtonpost.com/news/theworldpost/wp/2018/01/08/carbon-emissions/?utm\\_term=.ea608a301e371](https://www.washingtonpost.com/news/theworldpost/wp/2018/01/08/carbon-emissions/?utm_term=.ea608a301e371) (“At the moment, most methods cost more than \$100 per ton, but there are dramatic developments which promise great improvement.”).

225. Hansen et al., *supra* note 20, at 13.

226. *See id.* at 10.

227. *Understanding Global Warming Potentials*, *supra* note 144.

228. Hansen et al., *supra* note 20, at 12.

229. *Id.*

230. *Id.*

Overall, the science produced by the Hansen team is statistically significant, indicating high confidence calculations. The multiple scenarios that define the rate at which fossil fuel emissions must be phased down to restore Earth's energy balance and stabilize the global climate system are both falsifiable and mathematically precise.<sup>231</sup> Redundant methodology, via thousands of Argo Floats, provides the basis for which logarithmic calculations can be made and retested. With the completion of a 90% distribution of Argo Floats throughout the oceans, coupled with a reduction of calibration problems, it is confirmed that the Earth's heat energy imbalance assures increasing climate impacts.<sup>232</sup>

#### V. REFLECTION AND THE CHALLENGES AND OPPORTUNITIES THAT LIE AHEAD

The children plaintiffs have an incredible task, moving forward. The next step for the *Juliana* case is trial. On October 29, 2018,<sup>233</sup> (and for the following forty-nine days set apart for trial) the children must prove to the court that the federal government's past and ongoing actions, and inactions, violate the children's constitutional right as articulated by Judge Aiken—a task that extends far beyond proving to the court the validity of the scientific consensus.<sup>234</sup>

Until trial, the discovery process will be the most demanding challenge for both parties. Discovery requests issued by the children to the named defendants will essentially force the government to respond to past and current denials of the government's contribution to the threat of climate change. Additionally, the fossil-fuel industry, as intervenors, will also be subject to discovery requests.<sup>235</sup> These requests will enable information to be gathered, which has never before been assessed by the judiciary in such comprehension.<sup>236</sup> That is, the fossil fuel industry's internal communications, policies and reports related to climate change, and other materially relevant information in connection with the allegations against the federal government will be available for examination.<sup>237</sup>

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231. See *supra* Table 1:1.

232. In turn, type I errors are greatly minimized due to the high level of significance afforded to these measurement calculations. See Courtney Taylor, *What Level of Alpha Determines Statistical Significance?*, THOUGHTCO. <https://www.thoughtco.com/what-level-of-alpha-determines-significance-3126422> (last updated June 25, 2018). Thus, the maximum probability that the Hansen team encounters a type I error (rejecting an alternative hypothesis when that alternative hypothesis was actually true) in their prediction is significantly low, and, as a result, there is high probability that a type II error (rejecting the conclusion of their tested hypothesis when that conclusion was actually true) will occur if the prescription is not followed. *Id.*

233. *But see* CLIMATE CHANGE LITIG. DATABASES, *supra* note 1.

234. See Blumm & Wood, *supra* note 128, at 37–38.

235. *Id.*

236. *Id.*

237. Complying with the children's discovery requests has already turned out to be a difficult task for the fossil fuel industry. Three major trade groups have exited the case, as they were unable to agree on the causes and effects of greenhouse gases. See *generally* *Juliana v. United States*, COLUM. L. SCH.: SABIN CTR. CLIMATE CHANGE L. (Aug. 29, 2018, 2:31 PM), <http://climatecasechart.com/case/juliana-v-united-states/>.

During trial, one of the eighteen expert witnesses, Nobel-winning economist, Joseph Stieglitz, is set to testify on behalf of the children pursuant to his expert report.<sup>238</sup> In his expert report, Stieglitz explained that not only is it feasible for the United States to move the economy away from fossil fuels, but it is also greatly beneficial.<sup>239</sup> The United States could make this transition, he continued, by utilizing basic economic tools for dealing with externalities—specifically by imposing a tax or levy on carbon and by eliminating subsidies on fossil fuel production.<sup>240</sup> Based on his reasoning, Stieglitz concluded that costs of mitigating climate change now are economically manageable, and if the United States were to make such changes, “the net societal [financial] gain would more than outweigh the net societal [financial] loss.”<sup>241</sup> In contrast, he furthered, if the United States remains on its current course, it will impose unacceptably high costs and risks on rising generations.<sup>242</sup> Stieglitz’s expert report, coupled with the many others, will assuredly produce a convincing record before the court, and in turn, enhance the likelihood of a successful outcome for the children.

Litigation around climate change is a rapidly rising trend in the United States and around the world (see Table 1:2).<sup>243</sup> If the children are successful with their litigation strategy and a constitutional right is declared, the potential effects on mitigating the environmental degradation of common pool resources would be immense—both as applied and as case precedent.<sup>244</sup> Theoretically, the declared right

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238. Joseph Stieglitz, Ph.D., is an economics professor at Columbia University, former World Bank chief economist, and was one of the lead authors of the 1995 Report of the Intergovernmental Panel on Climate Change. Stieglitz was awarded with the Nobel Memorial Prize for economics in 2001 and shared the Nobel Peace Prize in 2007. See Expert Report of Joseph E. Stieglitz, Ph.D., *Juliana v. United States*, 217 F.Supp.3d 1224 (D. Or. June 28, 2018) (No. 6:15-cv-01517-TC), Document 266–1.

239. *Id.* At present, the U.S. lacks a comprehensive carbon-pricing regime that accounts for the negative externalities of burning fossil fuels such that private markets can be relied on to make efficient decisions. *Id.* Thus, producers and sellers of fossil fuels consider only their private costs and benefits, and the costs that their activities are imposing on society through, among other factors, increased GHG emissions and long-term climate effects. *Id.*

240. *Id.* at 32–40. In January 2018, President Trump approved tariffs on imported solar cells that start at 30%. Julia Pyper, *New Tariffs to Curb US Solar Installations by 11% Through 2022*, GREENTECH MEDIA (Jan. 23, 2018), <https://www.greentechmedia.com/articles/read/tariffs-to-curb-solar-installations-by-11-through-2022#gs.hoyAWT4>. The tariffs are unlikely to benefit American solar manufacturing jobs, but, according to the Solar Energy Industries Association, are likely to result in the loss of 23,000 American jobs this year and the delay or cancelation of billions in solar investments. *Id.* The tariffs are also expected to lead to a net reduction in solar installations by roughly 11% between 2018 and 2022, a 7.6-gigawatt reduction in solar PV capacity, which means approximately 1.2 million homes will not be powered by renewable solar energy. *Id.* Such tariffs are both harmful for the environment and the economy. *Id.*

241. Stieglitz, *supra* note 238, at 8. These benefits are a result of continued technological development in the renewables sector. *Id.* Because of technological improvements, the costs of renewables and storage are decreasing. The price of solar panels has dropped by more than half in recent years (80% reduction from 2008 to 2016). *Id.* As these technologies continue to improve and the efficiency increases, while manufacturing costs drop, these technologies will more easily substitute for existing fossil fuel infrastructure. *Id.* at 28 (footnotes omitted).

242. *Id.* at 8. There is broad consensus among economists, and the High-Level Commission concluded, that limiting temperature increase to “well below 2 degrees Celsius” is achievable with reasonable and modest measures, and that the costs of those measures are far smaller than the costs of the damage that climate change could inflict. See HIGH-LEVEL COMM’N ON CARBON PRICES, REPORT OF THE HIGH-LEVEL COMMISSION ON CARBON PRICES app. A at 52, app. B at 53 (2017).

243. See *infra* Table 1:2.

244. See Blumm & Wood, *supra* note 128, at 86.

would enable a judge to order an accounting against the political branches of the federal government.<sup>245</sup> Such accounting would require the government to monitor its pollutant load including, but not limited to, CO<sub>2</sub> emissions and demonstrate to a court that it is conserving public trust resources in accordance with the scientifically defined fiduciary obligation.<sup>246</sup> In turn, if the political branches do not uphold their obligation as trustees, there could be injunctions that would subject those officials to contempt of court, unless they halt the activities that are substantially impairing those essential natural resources.<sup>247</sup>

If a fundamental right is declared by the court and the atmosphere is protected as a public trust asset, then direct questions with respect to practical accountability will inevitably arise. The designer of the Atmospheric Trust Litigation theory, Professor Mary Wood at the University of Oregon School of Law, has articulated three future-oriented accountability issues facing the courts: First, the courts must recognize the paramount judicial “role in upholding the rights of the plaintiffs.”<sup>248</sup> “Second, the court[s] must issue declarations of principle” that will guide government actors and provide “a framework for the remedy.”<sup>249</sup> “Third, the court[s] must manage the remedy so that it offers a practical means to enforce the rights of the plaintiffs.”<sup>250</sup>

The relevance of addressing these accountability issues hinges on the overall success sought by the children.<sup>251</sup> However, determining the probability of such success is highly difficult to predict.

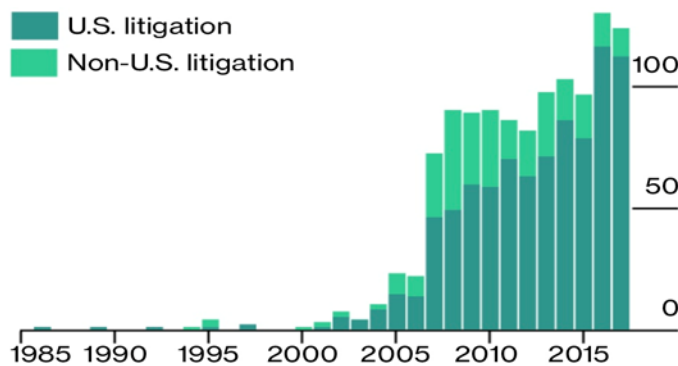


Table 1:2. Graph depicting the number of climate change lawsuits by year.<sup>252</sup>

245. *Id.*

246. *See id.* at 71–72.

247. *Id.* at 64–67, 71–72.

248. *Id.* at 67.

249. *Id.*

250. *See Blumm & Wood, supra* note 128, at 67.

251. *Id.*

252. Jeremy Hodges, Lauren Leatherby & Kartikay Mehrota, *Climate Change Warriors' Latest Weapon of Choice is Litigation*, BLOOMBERG (May 24, 2018), <https://www.bloomberg.com/graphics/2018-climate-change-lawsuits/>.

Alternatively, if the children are unsuccessful, that is—if the children are not declared to have a fundamental right to a viable atmosphere—further inquiries extend beyond the workings of the government to the effects on extra-legal areas of society and culture. Scientists are unequivocal in their conclusion that retaining the status-quo for even a few decades would guarantee a massive transition leading to climate impacts that would be out of the future generations' control.<sup>253</sup> Without adequate mitigation measures against the federal government now, there is greater demand placed on rising generations to procure the adaptive capacity sufficient to maintain the Earth's climate system as it stands in its current stable state.<sup>254</sup> In turn, rising generations are left vulnerable to catastrophic, climate-related impacts.<sup>255</sup> Thus, because of this fact, the fundamental issue presented to the general public centers on the means in which the goal of intergenerational justice may be achieved.

## VI. CONCLUSION

The scientific consensus has confirmed that human-induced CO<sub>2</sub> emissions have driven the Earth out of energy balance and into the early stages of a runaway greenhouse effect—assuring rising generations will face increased warming and climate-related impacts. The political branches of the federal government have failed to respond to these concerns by means other than by clinging to the status-quo—that is, by means other than by deferring action to future generations. For that reason, the children plaintiffs in the preeminent Atmospheric Trust Litigation case, *Juliana v. United States*, have invoked the judiciary to hold the federal government accountable pursuant to constitutional safeguards in conjunction with the Public Trust Doctrine.

A declaration of a fundamental right to a climate system capable of sustaining human life, preserved and protected by the political branches of the federal government via public trust obligations, as articulated by Judge Aiken, is legally viable. It is both feasible and beneficial for the United States to move its economy away from fossil fuel reliance, and the costs of mitigating climate change are now manageable. Regardless of the children's success at trial and in potential future proceedings, the *Juliana* case will reveal to the general public the failure of the federal government to react responsibly to the warnings generated by the scientific consensus—exposing to society the underlying issue regarding this generations' procurement of intergenerational equity.

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253. Hansen et al., *supra* note 20, at 21.

254. See also Barbara Cosens, Lance Gunderson & Brian Chaffin, *The Adaptive Water Governance Project: Assessing Law, Resilience and Governance In Regional Socio-Ecological Water Systems Facing a Climate Change*, 51 NAT. RESOURCES & ENVTL. L. ED. IDAHO L. REV. 1 (2014). See generally Barbara A. Cosens et al., *The Role of Law in Adaptive Governance*, ECOLOGY & SOC'Y (Mar. 2017), <https://www.ecologyandsociety.org/vol22/iss1/art30/>.

255. Hansen et al., *supra* note 20, at 21.