Nos. 12-15131, 12-15135

IN THE UNITED STATES COURT OF APPEALS
FOR THE NINTH CIRCUIT

ROCKY MOUNTAIN FARMERS UNION, et al.,
Plaintiffs-Appellees,

v.

JAMES N. GOLDSTENE, in his official capacity as
Executive Officer of the California Air Resources Board, et al.
Defendants-Appellants,

ENVIRONMENTAL DEFENSE FUND, et al.,
Intervenors-Defendants-Appellants.

On Appeal from the United States District Court
for the Eastern District of California
Fresno Division Case Nos. 1:09-cv-02234-LJO and 1:10-cv-00163-LJO
The Honorable Lawrence J. O'Neill, Judge

BRIEF OF *AMICI CURIAE* KEN CALDEIRA, Ph.D., W. MICHAEL HANEMANN, Ph.D., JOHN HARTE, Ph.D., KATHARINE HAYHOE, Ph.D., JAMES C. McWILLIAMS, Ph.D., MICHAEL OPPENHEIMER, Ph.D., TERRY ROOT, Ph.D., RICHARD SOMERVILLE, Ph.D., JOHN M. WALLACE, Ph.D., JAMES ZACHOS, Ph.D., and WILLIAM R.L. ANDEREGG, IN SUPPORT OF DEFENDANTS-APPELLANTS

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INTERESTS OF *AMICI*

Amici are scientists with expertise on the impacts from climate change in California. *See* Appendix for detailed biographies.[1] As scientists who conduct research on environmental issues that are relevant to policy decisions, *Amici* have an interest in states' abilities to use scientific evidence and methods to make laws and regulations. Because the legal standards for evaluating the constitutionality of a state policy depend on the purpose and design of the policy in question, *Amici* submit this brief to explain the expected impacts from climate change in California and how the State's Low Carbon Fuel Standard ("LCFS") mitigates these concerns. *Amici* also explain the necessity of evaluating the lifecycle emissions of transportation fuels from a physical climate science perspective.

INTRODUCTION [2]

California has a valid interest in creating policies that mitigate global climate change, which threatens its natural and social systems. Climate change puts the State's water supply, public health, coastal resources, energy and transportation infrastructure, agriculture, and wildlife at risk. Because each additional ton of greenhouse gas emitted to the atmosphere increases the magnitude of climate

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[1] *Amici* submit this brief in their personal capacities as individual scientists and not on behalf of any university, scientific organization, or professional society.

[2] None of the parties or their counsel authored any portion of this brief, nor did they or any other person contribute money to prepare or submit this brief. Fed.R.App.P. 29(c)(5). All parties consented to the filing of *amicus* briefs.

change, policy decisions that reduce greenhouse gas emissions caused by California's economic activities can mitigate these risks. Greenhouse gas emissions from transportation fuels are particularly important, as they account for 38 percent of California's net emissions.[3] Thus, limiting the greenhouse gas intensity of transportation fuels sold in California through the State's LCFS is a crucial step in reducing the risks posed by climate change.

From a scientific perspective, the LCFS appropriately considers greenhouse gases emitted during the production, distribution, and combustion of transportation fuels. The use of transportation fuels in California leads to emissions from all phases of a fuel's lifecycle. Wherever they occur, these emissions contribute equally to climate change and its impacts within California. Similarly, the climate benefits to California from emissions reductions are the same wherever the reduction takes place. Therefore, reducing the carbon intensity of California's transportation fuels – as measured by the emissions caused during the production, distribution, and combustion of those fuels, irrespective of the location of those emissions – mitigates the risks that California faces from a changing climate.

If the State's climate policy were required to ignore known sources of emissions associated with the consumption of transportation fuels, as the court below suggests, the LCFS would be decidedly less effective at mitigating the

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[3] California Air Resources Board, California Greenhouse Gas Inventory for 2000-2009 (2011).

negative impacts from climate change. For this reason, the Court should affirm the State's ability to use the best available scientific practices in setting climate policy by upholding the LCFS at issue in this case.

DISCUSSION

I. California Already Experiences and Will Continue to Experience Significant Impacts from Climate Change on Important Natural and Social Systems.

Global climate change poses significant threats to natural and social systems, according to a review by the Intergovernmental Panel on Climate Change ("IPCC"), an organization that relies on thousands of scientists to produce periodic reviews of the peer-reviewed climate science literature. Results from the IPCC's global assessments establish a clear basis for concern, which prominent American scientific organizations, such as the American Geophysical Union, the American Association for the Advancement of Science, the American Meteorological Society, and others,[4] have examined, validated, and reiterated. According to the National Academy of Sciences, delays in reducing greenhouse gas emissions

4 Letter from the American Association for the Advancement of Science to various United States Senators (Oct. 21, 2009) (signed by official representatives of eighteen scientific societies), *available at* http://www.aaas.org/news/releases/2009/media/1021climate_letter.pdf.

"could commit the planet to a wide range of adverse impacts."[5] Because the scale of these impacts is so great, "waiting for unacceptable impacts to occur before taking action is imprudent."[6]

There is also a large and continuously expanding body of high-quality scientific research specifically examining the current and expected impacts of climate change in California. In order to extend studies conducted at the global and national levels, the scientific community produced the Second California Assessment in 2009, a suite of studies examining the expected impacts in California from climate change. The results were published in a special volume of the peer-reviewed scientific journal *Climatic Change*.[7]

As the name suggests, the Second California Assessment is the second in an ongoing series of scientific reviews examining expected impacts from climate change in California. A Third California Assessment is due out by July 2012. Both Assessments build on an earlier peer-reviewed effort, the California climate

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5 National Research Council Committee on America's Climate Choices, America's Climate Choices 2 (2011) (hereinafter "National Research Council"), *available at* http://dels.nas.edu/Report/Americas-Climate-Choices/12781.

6 *Id*.

7 Daniel R. Cayan et al. (eds.), *California Second Assessment: New Climate Impacts Studies and Implications for Adaptation*, 109 Climatic Change S1 (2011), *available at* http://www.springerlink.com/content/ 0165-0009/109/s1/.

change scenarios project,[8] as well as a significant body of scientific literature that was published before the organized assessment process began.[9]

In addition to assessing the expected impacts from climate change, the scientific community also released a set of peer-reviewed studies examining California's climate adaptation needs. For this project, scientists considered strategies and options for adapting to the impacts from climate change that the State does not avoid through mitigation of greenhouse gas emissions.[10] The Third California Assessment will continue this line of analysis, incorporating estimates of vulnerabilities and climate adaptation strategies.

Collectively, these efforts produce a significant scientific record documenting the already-experienced and expected impacts from climate change in California. The results are based on careful study, consistent methodologies, and feedback from peer reviewers. While the science of climate change will never be "final" in the sense of being able to perfectly predict the future, these studies represent the state-of-the-art in climate impacts, vulnerability, and adaptation

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8 Daniel R. Cayan et al. (eds.), *California at a Crossroads: Climate Change Science Informing Policy*, 87 Climatic Change S1 (2008), *available at* http://www.springerlink.com/content/0165-0009/87/s1/.

9 *E.g.*, Katharine Hayhoe et al., *Emissions pathways, climate change, and impacts on California*, 101 Proc. Nat'l Acad. Sci. 12422 (2004).

10 Louise Bedsworth & Ellen Hanak (eds.), *Preparing California for a Changing Climate*, 111 Climatic Change 1 (2012), *available at* http://www.springerlink.com/content/0165-0009/111/1/.

science. Together, they illustrate the significant climate threats California is facing if warming and related climate changes are not significantly abated through mitigation of greenhouse gases.

A. The Scientific Consensus on Global Climate Change Is Firmly Established and Widely Accepted.

The scientific consensus on global climate change is nearly universal within the expert community.[11] According to the IPCC, evidence that the world is warming is "unequivocal."[12] Crucially, the IPCC found that greenhouse gas emissions caused by human activity explain "[m]ost of the observed increases in global average temperatures since the mid-20th century."[13] Failing to reduce greenhouse gas emissions will cause further warming and lead to "changes in the

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[11] William R. L. Anderegg et al., *Expert credibility in climate change*, 107 Proc. Nat'l Acad. Sci. 12107 (2010) (finding that over 97 percent of active climate scientists agreed with the basic IPCC findings).

[12] IPCC, Climate Change 2007: Synthesis Report Summary for Policymakers 1, 2 (2007), *available at* http://www.ipcc.ch/pdf/ assessment-report/ar4/syr/ar4_syr_spm.pdf.

[13] *Id*. at 5. The IPCC assigned this statement a likelihood of 90 to 100 percent. Recent studies extend this finding even further, suggesting that the warming effects of human-induced greenhouse gas emissions are actually greater than warming observed to date; these studies find that human-induced warming has been tempered by the cooling effects of natural climate cycles (such as the El Niño cycle), reducing the extent of total warming. Grant Foster & Stefan Rahmstorf, *Global temperature evolution, 1979-2010*, 6 Envtl. Res. Letters, 044022, at 6 (2011); N.P. Gillett et al., *Improved constraints on 21st century warming derived using 160 years of temperature observations*, 39 Geophysical Res. Letters, L01704, at 5 (2012).

global climate system . . . larger than those observed during the 20th century."[14]

The significance of these conclusions is difficult to overstate in either scientific or political terms. The IPCC reports' authors responded to thousands of comments from peers and government experts.[15] Furthermore, nearly every country in the world – including the United States, fast-growing countries like China, and oil-rich nations like Saudi Arabia – could have objected to the final reports, potentially delaying or preventing their publication if the objection identified a weakness in the final report.[16] None did so, however, and government representatives approved the document from which the quotes above were taken after reviewing it line-by-line.[17] As a result, the IPCC findings represent a firm

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[14] IPCC, *supra* note 11, at 7. The IPCC assigned this statement a likelihood of 90 to 100 percent.

[15] IPCC, Formal Government and Expert Review of First Order Draft (2007), *available at* http://www.ipcc.ch/publications_and_data/ar4/syr/en/contents.html; IPCC, Comments on the Final Government Draft (2007).

[16] IPCC Synthesis Reports must be approved line-by-line at a plenary meeting of government representatives to the IPCC. *See* IPCC, Appendix A – Procedures for the Preparation, Review, Acceptance, Adoption, Approval and Publication of IPCC Reports § 4.6.1 (2011) (establishing the process for approving synthesis reports and summaries), *available at* http://www.ipcc.ch/pdf/ipcc-principles/ipcc-principles-appendix-a-final.pdf. While consensus is the goal, any government that objects to the approval of a synthesis report or summary may choose to have its objection recorded in the meeting notes. IPCC, Principles Governing IPCC Work § 10 (2006), *available at* http://www.ipcc.ch/pdf/ipcc-principles/ipcc-principles.pdf.

[17] Twenty-Seventh Session of the Intergovernmental Panel on Climate Change, Valencia, Spain, Nov. 12-17, 2007, *Report of the 27th Session of the IPCC* §

baseline of scientific knowledge about climate change.

The climate consensus is similarly robust within the national scientific community. The National Research Council of the U.S. National Academies, the nation's preeminent independent scientific advisory organization, reviewed the IPCC's findings and reached similar conclusions, noting:

> [T]he fundamental causes and consequences of climate change have been established by many years of scientific research, are supported by many different lines of evidence, and have stood firm in the face of careful examination, repeated testing, and the rigorous evaluation of alternative theories and explanations.[18]

The U.S. Global Change Research Program, a congressionally mandated coordinating body for federal climate and global change research, stated in its 2009 National Climate Assessment that observed global warming "is due primarily to human-induced emissions of heat-trapping gases."[19] Furthermore, the U.S. Environmental Protection Agency concluded that greenhouse gases are reasonably

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4.1 (noting line-by-line discussion and approval of the Summary for Policymakers of the Synthesis Report; no objections recorded), *available at* http://www.ipcc.ch/meetings/session27/final-report.pdf.

[18] National Research Council, *supra* note 4, at 15.

[19] United States Global Change Research Program, Global Climate Change Impacts in the United States 9 (Thomas R. Karl et al. eds., 2009), *available at* http://www.globalchange.gov/usimpacts.

anticipated to endanger the public health and welfare.[20] The EPA finding explicitly incorporates a review of the expected impacts from climate change, using the IPCC and U.S. Global Change Research Program reports.[21] As these statements indicate, numerous prominent American scientific institutions and federal entities obligated to use the best available science in their activities have repeatedly validated the foundations of climate change science.

While the problem of climate change is vast, it is also, at a certain level, easily understood. According to the National Research Council, "[e]ach additional ton of greenhouse gases emitted commits us to further change and greater risks."[22] This is because each ton contributes equally to global climate change, wherever it is emitted. By implication, each ton avoided reduces the risks from climate change, wherever it is avoided. Therefore, the extent to which California experiences impacts from a changing climate depends on the emissions California releases to the atmosphere, as well as the emissions caused by others in the United States and around the world.

Although California cannot solve the problem of global climate change

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[20] Endangerment and Cause or Contribute Findings for Greenhouse Gases Under Section 202(a) of the Clean Air Act, 74 Fed. Reg. 66496, 66516 (Dec. 15, 2009) (to be codified at 40 C.F.R. Ch. 1).

[21] *Id.* at 66516.

[22] National Research Council, *supra* note 4, at 15.

alone, the State should be allowed to take action. As the Supreme Court has recognized, while a reduction in domestic greenhouse gas emissions "will not by itself reverse global warming," reduced emissions "would slow the pace of global emissions increases, no matter what happens elsewhere." *Massachusetts v. Envtl. Prot. Agency*, 549 U.S. 497, 525-26 (2007). Here, the LCFS emissions reductions are part of a comprehensive policy scheme that is broadly consistent with the long-term emissions reductions necessary to meet targets currently under global negotiation.[23] With the eighth largest economy in the world, California is appropriately pursuing problem-solving measures to address climate change, and the Court should not supplant the Air Resources Board's incremental policy innovation efforts. Indeed, "[a]gencies, like legislatures, do not generally resolve

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[23] The State's comprehensive climate policy includes a legislative mandate to reduce greenhouse gas emissions to 1990 levels by 2020. Cal. Health & Safety Code § 38550. In addition, Former Governor Schwarzenegger issued an Executive Order that sets a target of an 80 percent reduction below 1990 emissions levels by 2050. Cal. Exec. Order No. S-3-05, ¶ 1 (June 1, 2005), *available at* http://gov38.ca.gov/index.php?/print-version/executive-order/1861/. This long-term target is consistent with emissions reductions necessary to manage climate change at levels under discussion in international negotiations. Malte Meinshausen et al., *Greenhouse-gas emission targets for limiting global warming to 2 °C*, 458 Nature 1158, 1160 (2009) (analyzing emissions scenarios that are consistent with limiting global warming to an increase of 2 °C); United Nations Framework Convention on Climate Change, Report of the Conference of the Parties on its fifteenth session, FCCC/CP/2009/11/ Add.1 (Mar. 30, 2009), Decision 2/CP.15 at 5, ¶ 2 (the "Copenhagen Accord") (establishing an aspirational target of limiting global warming to 2 °C in a non-binding agreement to which the United States is a party).

massive problems in one fell regulatory swoop . . . They instead whittle away at them over time, refining their preferred approach as circumstances change and as they develop a more nuanced understanding of how best to proceed." *Id.* at 524 (citing *Williamson v. Lee Optical of Okla., Inc.*, 348 U.S. 483, 489 (1955) ("[A] reform may take one step at a time, addressing itself to the phase of the problem which seems most acute to the legislative mind")).

B. Global and National Studies Project Significant Impacts from Climate Change on Natural and Social Systems, Many of Which Will Manifest in California.

Global climate models project significant impacts from a changing climate, presenting concerns for natural and social systems in California. These impact projections are generated in a multi-step process. First, scientists create an emissions scenario that represents the quantity of greenhouse gases added to the atmosphere over a given time horizon. Next, scientists project the response of the physical climate to the emissions scenario. Finally, studies link changes in the physical climate to impacts on natural or social systems. Because the extent of climate change depends on total greenhouse gas emissions, the range of projected impacts always depends on the choices made about emissions in the coming decades.

Each type of impact from climate change has a distinct causal chain, but most are a consequence of changes to either the temperature or precipitation regimes. That greenhouse gases warm the Earth's surface was established 200 years ago; greenhouse gases trap heat in the atmosphere that would otherwise escape into space, raising the planet's temperature, though not equally across all locations. The impacts on precipitation are perhaps less intuitive, but equally well-founded in the physical science principles that (1) warmer air can hold more water vapor and (2) warmer temperatures increase the rate at which water evaporates. Global models generally project further drying at those places and times that are already dry, such as the southwestern United States in summer, and more rainfall and more intense storms at those places and times that are already wet.

Models also project increasing intensity for storms and other temperature- and rainfall-related weather phenomena. In a warmer world, individual storms can be more intense, causing more rain to fall in a single burst, followed by extended dry periods between rainfall events. Thus, greenhouse gas emissions tend to increase the percentage of precipitation that falls during extreme weather events – a pattern already confirmed across much of the northern hemisphere.[24] As a result, many parts of the world can expect to experience both dryer conditions and more damage from intense weather events, which can include flooding.

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[24] Seung-Ki Min et al., *Human contribution to more-intense precipitation extremes*, 470 Nature 378, 378 (2011).

One important impact from greenhouse gas emissions that does not trace to either altered temperature or precipitation regimes is ocean acidification. Emissions of carbon dioxide to the atmosphere increase the amount of carbon dioxide that is dissolved in the ocean, and the result is ocean acidification: dissolved carbon dioxide reacts with seawater to form carbonic acid. Carbonic acid then acts to reduce the availability of carbonate ions, a raw material that important marine organisms, such as coral, plankton, and shellfish, use to make their shells and skeletons. Ocean acidification is worrisome because it is expected to have serious consequences for these species, their associated fisheries, tourism industries, and the people who rely on them for food or income.[25] To give a sense of scale, unmitigated carbon dioxide emissions are projected to result in ocean acidification beyond any levels found in the 300 million year historical record.[26]

Beyond the most immediate changes in temperature and rainfall, a warmer climate raises other concerns. Heat waves are expected to increase in frequency, intensity, and duration, with increased risk for public health impacts, especially

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[25] Ove Hoegh-Guldberg et al., *Coral Reefs Under Rapid Climate Change and Ocean Acidification*, 318 Science 1737 (2007).

[26] Ken Caldeira & Michael E. Wickett, *Oceanography: Anthropogenic carbon and ocean pH*, 425 Nature 365 (2003); Bärbel Hönisch et al., *The Geological Record of Ocean Acidification*, 335 Science 1058 (2012).

among the elderly.[27] A recent Special Report from the IPCC expanded this finding, concluding that it is "virtually certain that increases in the frequency and magnitude of warm daily temperature extremes . . . will occur in the 21st century at the global scale."[28] This statement has two components. First, extreme events will be more common around the world. High temperatures that are currently experienced only once every twenty years are likely to become as common as once every two to five years by the end of the century, depending on the amount of greenhouse gases emitted.[29] As an example of the frequency of extreme heat events, Sacramento currently averages about four extreme heat days per year, but is projected to experience about 50 extreme heat days per year by the end of the century under a high greenhouse gas emissions scenario.[30] Second, extreme events will be more intense. Averaged across the world, daily maximum temperatures that occur once every 20 years will likely be an additional 3.5 to 9.0 degrees

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27 National Research Council, *supra* note 4, at 15.

28 IPCC, *Summary for Policymakers*, Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaptation 3, 13 (Chris B. Field et al. eds., 2012). With generally warming climate conditions, the IPCC also expects extreme cold temperatures to become less common and less extreme. *Id*.

29 *Id*. As used by the IPCC, the term "likely" refers to a confidence level of between 66 and 100 percent.

30 Cal-Adapt Extreme Heat Tool (high emission scenario for Sacramento, CA, based on data from Scripps Institute of Oceanography), *available at* http://cal-adapt.org/temperature/heat/.

Fahrenheit warmer by the end of the century, depending in part on future emissions.[31] These projections demonstrate that the expected temperature impacts of climate change present risks of significant consequences for public health, agriculture, and natural ecosystems.

The U.S. Global Change Research Program analyzed expected impacts from climate change at the regional level for the United States, confirming the basic IPCC findings and adding localized details.[32] The report found that climate change "already appears to be influencing both natural and managed ecosystems" in the Southwest, including California.[33] Looking to the future, the U.S. Global Change Research Program projected significant temperature changes in the Southwest – by as much as an average of four to ten degrees Fahrenheit warmer by the end of this century, depending in part on future emissions.[34]

Although worrisome on their own, these average changes mask larger annual variations. Summer temperature increases are expected to be greater than the yearly average, and urban "heat island" effects, which raise temperatures in and

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[31] IPCC, *supra* note 27, at 13.

[32] U.S. Global Change Research Program, *supra* note 18, at 129-34.

[33] *Id.* at 131.

[34] *Id.* at 129.

around populated areas, could further exacerbate the impacts.[35] Thus, by the end of the century, the hottest summer day will be warmer than the annual average increase in temperature, and even warmer still in many cities.

Significant heat events like these have a number of human health impacts, threatening elderly and infirm populations. Examining heat-related climate impacts, the U.S. Global Change Research Program study concluded that a warming climate could result in two to three times as many heat-related deaths in Los Angeles by the end of the century for a low emissions scenario, and five to seven times as many heat-related deaths for a high emissions scenario.[36] Furthermore, warmer temperatures increase the rate at which local air pollutants, such as ozone, form. These air quality problems lead to even higher rates of illness and premature death.

The situation is no more optimistic for water resources. Reviewing projections from global climate models, IPCC member governments (including the United States) concluded that warming in western U.S. mountain areas is expected to "cause decreased snowpack, more winter flooding, and reduced summer flows,

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[35] *Id*. (citing S. Guhathakurta & P. Gober, *The impact of the Phoenix urban heat island on residential water use*, 73 J. Am. Plan. Ass'n 317 (2007)).

[36] *Id.* at 91. If residents do not change behaviors to adapt to warmer temperatures, death rates would be 20 to 25 percent higher. *Id*.

exacerbating competition for over-allocated water resources."[37] These changes to the water regime can be expected to have impacts on protected species and ecosystems as well. At the regional level, the U.S. Global Change Research Program projects that water supplies will become "increasingly scarce" due to reductions in rain and snowfall during winter and spring, earlier snowmelts, and decreases in spring snowmelt volumes.[38] With continued greenhouse gas emissions, climate models show a northward shift of winter and spring storm tracks, resulting in less precipitation in the Southwest.[39]

Together, these temperature and precipitation impacts will increase wildfires, encourage invasive species, and threaten agriculture. The total area burned by wildfires in the western United States is expected to increase with climate change, with more frequent fires in formerly wet forests, and smaller fires in areas where reduced precipitation reduces the growth of fine fuels, such as grasses.[40] As temperatures rise, species will generally shift their geographic ranges

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[37] IPCC, *Summary for Policymakers*, Climate Change 2007: Impacts, Adaptation, and Vulnerability 1, 14 (Martin L. Parry et al. eds., 2007).

[38] U.S. Global Change Research Program, *supra* note 18, at 129-30.

[39] *Id*. at 130. The impacts in California are expected to vary geographically, with an unequal distribution of precipitation changes. The Northern Sierra Nevada are expected to receive comparable levels of or slight increases in precipitation, while the Southern Sierra Nevada are expected to receive decreased precipitation.

[40] *Id*. at 131.

northward.[41] Shifting species ranges, in combination with increased stresses on native ecosystems from temperature and precipitation changes, could encourage invasive species to thrive at the expense of native species.[42] In addition, climate change could introduce fires into ecosystems that have not adapted to it, further exacerbating the threat to native species.[43]

Finally, heat waves and less frequent cool temperatures are likely to impact agriculture in California, particularly high-value fruit and nut crops that require chilling temperatures to set fruit for the following year.[44] A study of national agricultural data concluded that expected temperature and precipitation trends in a changing climate will reduce agricultural yields; indeed, these impacts have already been observed at both the national and regional level over the last 20 years.[45]

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[41] *Id*. Species may also shift to higher elevations to avoid temperature increases, which for certain native California species implies a southward trajectory. Scott R. Loarie et al., *Climate Change and the Future of California's Endemic Flora*, 3 Pub. Libr. Sci. ONE, e2502, at 3 (20090.

[42] *Id.* In some locations, climate change may harm invasive species more than it harms native species.

[43] *Id.*

[44] *Id.* at 134.

[45] David B. Lobell et al., *Climate Trends and Global Crop Production Since 1980*, 333 Science 616 (2011).

C. The Second California Assessment Projects Significant Deleterious Impacts from Climate Change on Natural and Social Systems in California.

The Second California Assessment highlights risks facing specific natural and social systems under a changing climate. We summarize them by category and note that these studies cover only a subset of topics covered in the assessment; much more could be written, especially since the timing of this brief predates the release of the Third California Assessment in July 2012.

<u>Water</u>

Adapting to new patterns and quantities of precipitation will impact hydropower production, flood management, and water supply systems in the state (including surface water and ground water). These impacts may require changes in water management operations, water allocation, and investment in water storage infrastructure, all of which will require more attention to multi-year precipitation patterns in order to avoid water shortages.[46] A study of water use in the Central Valley of California suggests that hotter temperatures will increase agricultural demand for water to the point of causing a decrease in water supply reliability,

[46] Christina R. Connell-Buck et al., *Adapting California's water system to warm vs. dry climates*, 109 Climatic Change S133, S147-48 (2011).

which better water management techniques could only partially offset.[47] A site-specific study of two high-elevation hydropower systems in the State suggests that even after adopting new management techniques to adapt to a changing climate, the facilities will remain sensitive to extreme dry and wet periods.[48] Dry periods could reduce the ability of California's system of dams to meet power or water demand, and extreme wet periods may result in downstream flooding in the Sacramento area.[49] Flooding events in the Southern Sierra Nevada are generally expected to become larger and may also become more frequent.[50] Changes in snowmelt patterns driven by climate change are likely to exacerbate water problems by causing snow to melt earlier in the year and runoff to decrease later in the year, putting additional pressure on the state water system during periods of high water demand.[51]

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[47] Brian A. Joyce et al., *Modifying agricultural water management to adapt to climate change in California's central valley*, 109 Climatic Change S299, S299-300 (2011).

[48] Sebastian Vicuña et al., *Climate change impacts on two high-elevation hydropower systems in California*, 109 Climatic Change S151, S166-68 (2011).

[49] *Id.*

[50] Tapash Das et al., *Potential increase in floods in California's Sierra Nevada under future climate projections*, 109 Climatic Change S71, S88-90 (2011). The frequency of future flooding events depends on whether the trend towards dryer conditions is stronger than the rate at which storm intensity increases. *Id.*

[51] D. Waliser et al., *Simulating cold-season snowpack: Impacts of snow albedo and multi-layer snow physics*, 109 Climatic Change S95, S113-14 (2011). The

Sea Level Rise and Coastal Impacts

Sea levels on the California coast are currently expected to rise by as much as 4.5 feet by 2100, which increases the risk of coastal flooding and coastal erosion and puts at risk half a million people living on property worth over $100 billion.[52] Erosion from sea level rise is expected to result in California losing over 80 square miles of land.[53]

Beyond property damage, sea level rise will cause saltwater intrusion into the brackish estuarine waters of the Sacramento Delta and into other coastal groundwater reserves, affecting human and natural ecosystems.[54] As one of the major sources of water pumped from Northern California to the south, the Delta is a crucial element of the State's water system, and changes to Delta water quality could have ramifications for Southern California's water supply. From a natural ecosystems perspective, saltwater intrusion would dramatically alter the habitat

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primary impact studied in this paper is caused by black carbon, a pollutant emitted from burning fossil fuels. The effects of black carbon are related to but distinct from the warming and other climate effects of carbon dioxide emissions.

[52] Matthew Heberger et al., *Potential impacts of increased coastal flooding in California due to sea-level rise*, 109 Climatic Change S229, S246-47 (2011).

[53] David L. Revell et al., *A methodology for predicting future coastal hazards due to sea-level rise on the California Coast*, 109 Climatic Change S251, S273 (2011).

[54] CALFED Science Program, The State of Bay-Delta Science, 2008, at 143 (Michael C. Healy et al. eds., 2008).

conditions throughout the Delta.

In settled urban areas, sea-level rise will also threaten protected estuaries and marshes.[55] Absent a process of dismantling barriers (such as revetments, roads, and bulkheads) and restoring adjacent urban lands, marshes and estuaries would bear the brunt of erosion and submersion because they cannot retreat inland as sea levels rise.

Forests and Fires

Climate change is projected to retard the rate of growth of tree species on private timberlands in California, resulting in a loss of 4.9 to 8.5 percent of timber value by the end of the century, or over eight billion undiscounted dollars.[56] More significantly, the frequency and intensity of forest fires is projected to increase across many parts of California. Forest fire models project that by the end of the 21st century, a higher emissions scenario would increase the average burned area statewide between 36 and 74 percent, with a median estimate of 44 percent.[57] Under all emissions scenarios, the models project burn area increases of over 100

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[55] Daniel R. Cayan et al., *Climate change projections of sea level extremes along the California Coast*, 87 Climatic Change S57 (2008).

[56] L. Hannah et al., *The impact of climate change on California timberlands*, 109 Climatic Change S429, S441 (2011).

[57] A. L. Westerling et al., *Climate change and growth scenarios for California wildfire*, 109 Climatic Change S445 (2011).

percent in Northern California by the end of the century.[58]

Agriculture

Economic models for expected average temperature and precipitation changes identify climate change-induced risks to California's agricultural sector. Field crops grown in the Central Valley (such as hay, cotton, corn, wheat, tomato, rice, and sunflower) are often highly susceptible to changes in temperature and precipitation, with expected yield declines under all scenarios considered in the Second California Assessment.[59] Perennial crops (including fruit and nut trees, such as almonds) appear more resilient to average warming conditions, but the loss of chill hours – needed to "set" the trees' fruits – from warmer winters presents new risks.[60]

Although impacts to the value and yield of California crops are projected to be relatively modest under the average conditions expected with a changing climate, extreme events are a very different story. While extreme cold events will become less common (without entirely disappearing), heat extremes and precipitation extremes, and possible flooding resulting from high runoff, could

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58 *Id.* at S457.

59 Juhwan Lee et al., *Effect of climate change on field crop production in California's Central Valley*, 109 Climatic Change S335 (2011).

60 David B. Lobell & Christopher B. Field, *California perennial crops in a changing climate*, 109 Climatic Change S317, S332-33 (2011).

become more common. The net effect is uncertain, as good data exist for the costs of extreme cold events and floods, but less is known about agricultural responses to the temperature extremes projected for California.[61]

In aggregate, preliminary studies suggest climate change will result in lost agricultural profits. These studies, moveover, assume uninterrupted water supplies, which is not the most likely outcome from climate change. Although additional risks from water supply disruptions could increase the damages to agriculture, the available data are too limited to permit investigation of this possibility, and technological change and crop substitution may avoid or mitigate some of the potential damages.[62]

<u>Energy Demand</u>

Hotter temperatures will mean more demand for air conditioning, which may result in an increase of up to 55 percent in per capita residential electricity demand

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[61] David B. Lobell et al., *Climate extremes in California agriculture*, 109 Climatic Change S355, S362-63 (2011).

[62] Oliver Deschenes & Charles Kolstad, *Economic impacts of climate change on California agriculture*, 109 Climatic Change S365, S384-85 (2011); Josué Medellín-Azuara et al., *Economic impacts of climate-related changes to California agriculture*, 109 Climatic Change S387 (2011); L. E. Jackson et al., *Case study on potential agricultural responses to climate change in a California landscape*, 109 Climatic Change S407 (2011).

for the warmer scenarios considered in California.[63] Since winter heating in California relies primarily on non-electricity fuels, the expected declines in winter heating needs will not offset the growing demand for summer electricity. In general, increased energy demands from a changing climate will increase the risk of electricity blackouts and brownouts.[64]

II. The LCFS Appropriately Considers Greenhouse Gas Emissions from the Production, Distribution, and Combustion of Transportation Fuels Because These Sources Are Causally Linked and Contribute to Climate Change Wherever They Are Emitted.

Accurately observing and reducing greenhouse gas emissions caused by in-state consumption of transportation fuels requires policymakers to account for all known sources of emissions when setting regulations. Lifecycle assessment science addresses this need, as greenhouse gas emissions from the production, distribution, and combustion of transportation fuels are all causally linked to fuel consumption decisions. These emissions must be included in the accounting – whether explicitly in the final regulations or informally in the deliberative process – because they contribute equally to global climate change wherever they occur. Therefore, a state policy that seeks to reduce the greenhouse gas emissions

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63 Maximilian Auffhammer & Anin Aroonruengsawat, *Simulating the impacts of climate change, prices and population on California's residential energy consumption*, 109 Climatic Change S191 (2011).

64 Norman L. Miller et al., *Climate, Extreme Heat, and Electricity Demand in California*, 47 J. Applied Meteorology & Climatology 1834, 1835 (2007).

associated with California's consumption of transportation fuels must incorporate some accounting of the emissions from the production, distribution, and combustion of those fuels, whether or not those emissions sources fall within the state's borders.

A. Greenhouse Gas Emissions from the Production, Distribution, and Combustion of Transportation Fuels Are Causally Linked and Contribute Equally to Climate Change Wherever They Occur.

The production, distribution, and combustion of transportation fuels each create greenhouse gas emissions driven by demand for the fuel in question. Scientists comparing environmental impacts from different transportation fuels necessarily consider the production and distribution of these fuels because the choices made in the intermediate supply chain significantly affect total greenhouse gas emissions and can even determine the relative advantages of one fuel over another on the basis of objective metrics.

While a rich literature describes different methods of counting the emissions from transportation fuels production – the nuances of which are beyond the scope of this brief – there is agreement that counting these emissions sources is a critical part of greenhouse gas emissions accounting for biofuels (such as ethanol or biodiesel),[65] petroleum-based fuels (such as gasoline and diesel),[66] and electricity.[67]

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[65] Alexander E. Farrell et al., *Ethanol Can Contribute to Energy and Environmental Goals*, 311 Science 506 (2006) (a lifecycle analysis of ethanol);

Indeed, there would be no way to recognize any benefits from out-of-state production of biofuels without employing this approach.

Greenhouse gas emissions contribute to the problem of global climate change wherever they are emitted. Because carbon dioxide is well-mixed throughout the atmosphere and remains there for a long time, it does not matter whether a molecule of carbon dioxide was emitted in California, Nebraska, or China; the same physical quantity of emissions from each location will have the same contribution to global climate change as the others. By extension, the benefit to California from avoided impacts associated with global climate change is the same wherever the emissions reduction takes place.

B. The LCFS Appropriately Considered Greenhouse Gas Emissions from the Production, Transportation, and Combustion of Transportation Fuels.

Amici understand the legal question at the core of this case to be about

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Helena Chum et al., *Bioenergy*, *in* IPCC, Special Report on Renewable Energy Sources and Climate Change Mitigation (Ottmar Edenhofer et al. eds., 2011) (an assessment of biofuels' ability to contribute to reducing greenhouse gas emissions); Felix Creutzig et al., *Reconciling top-down and bottom-up modeling on future bioenergy development*, 2 Nature Climate Change 320 (2012) (reviewing methods for calculating greenhouse gas emissions from biofuels).

[66] National Energy Technology Laboratory, Development of Baseline Data and Analysis of Life Cycle Greenhouse Gas Emissions of Petroleum Based Fuels (2008) (reviewing emissions from petroleum fuels).

[67] Jeremy J. Michalek et al., *Valuation of plug-in vehicle life cycle air emissions and oil displacement benefits*, 108 Proc. Nat'l Acad. Sci. 16554 (2011) (reviewing emissions from electricity used for transportation).

whether the LCFS methodology of taking account of emissions from the production, transportation, and combustion of transportation fuels violates the Commerce Clause of the U.S. Constitution. We offer our view, as experts in climate science, that a rule prohibiting jurisdictions from considering the full lifecycle implications of greenhouse gas emissions from consumption choices would severely constrain public authorities' efforts to contend with this serious environmental problem.

Policymakers need to be able to look at more than end-use combustion (or "tailpipe") emissions because a meaningful comparison of transportation fuels cannot be made on this basis alone. In order to compare biofuels to conventional gasoline, for example, a policymaker must consider the agricultural practices employed when producing the biofuel feedstock. This is because agriculture "fixes" carbon dioxide from the atmosphere into plant tissues, generating a climate benefit – one that necessarily arises during the production phase and not at the tailpipe.

Electric vehicles present a similar problem. Because they have no tailpipes, they do not directly produce air pollution. Instead, electric vehicles cause emissions by consuming electricity produced from power plants that emit greenhouse gases and other pollutants. In order to assess the impact from electric vehicles, the regulator needs to calculate the greenhouse gas intensity of the electricity delivered to the electricity grid. These emissions sources are in the production and distribution phases of the fuel's lifecycle, not at the combustion (or tailpipe) stage.

Indeed, the entire logic of recognizing low-carbon transportation fuels in an interstate market is dependent on being able to credit and debit producers for out-of-state activity. For example, considering any greenhouse gas emissions benefits from a gallon of ethanol produced outside of California requires recognizing the carbon sequestration that occurred when the out-of-state farmer grew the ethanol feedstock. That one should also include the emissions associated with refining and shipping the fuel to market is merely the other side of the same methodological coin.

Each major component of lifecycle analysis for transportation fuels is a standard part of national and international greenhouse gas emissions accounting regimes. The production, distribution, and combustion of transportation fuels are all part of the IPCC Guidelines for National Greenhouse Gas Inventories.[68] These

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[68] Darío R. Gómez et al., *Chapter 2: Stationary Combustion*, *in* 2 IPCC Guidelines for National Greenhouse Gas Inventories § 2.1 (emissions from producing transportation fuels), *available at* http://www.ipcc-nggip.iges.or.jp/public/2006gl/index.html; Christina D. Waldron et al., *Chapter 3: Mobile Combustion*, 2 IPCC Guidelines for National Greenhouse Gas Inventories § 3.1 (emissions from combustion and distribution of transportation fuels); David Picard et al., *Chapter 4: Fugitive Emissions*, 2 IPCC Guidelines for National Greenhouse Gas Inventories § 4.1 (emissions from oil well and pipeline systems, part of production emissions for fossil fuels); Rodel D. Lasco et al.,

categories are also included in the U.S. Environmental Protection Agency's Inventory of Greenhouse Gas Emissions.[69]

For these reasons, a judicial prohibition preventing states from counting all standard emissions sources would hamper policymakers' ability to incorporate the best available environmental science into state policy decisions.

CONCLUSION

California faces significant impacts from climate change, which is projected to harm the state's natural and social systems, its infrastructure, and its economy. Greenhouse gas emissions from the production, distribution, and combustion of transportation fuels are causally linked to in-state fuel consumption decisions and contribute equally to the problem of climate change, wherever they occur. Similarly, reductions in emissions contribute to reducing the expected harms from climate change, wherever they are achieved. By setting targets for reducing the

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Chapter 5: Cropland, *in* 4 IPCC, 2006 IPCC Guidelines for National Greenhouse Gas Inventories § 5.1 (emissions from agriculture and land use change, part of production emissions for biofuels).

[69] U.S. Environmental Protection Agency, Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2009 § 3.7 (2011) (emissions from distribution of transportation fuels and production of fossil fuels for transportation), *available at* http://epa.gov/climatechange/emissions/ usgginventory.html; *id.* § 3.2 (emissions from electricity generation, part of production of transportation fuels); *id.* § 3.10 (emissions from combustion of biofuels); *id.* § 3.1 (emissions from combustion of fossil fuels for transportation); *id.* § 7 (emissions from land use change, part of production of biofuels).

emissions caused by in-state consumption of transportation fuels, the LCFS policy contributes to reducing the expected harms from climate change in California.

Moreover, accurately accounting for all known sources of emissions caused by the consumption of transportation fuels requires examining out-of-state emissions. The approach taken by the LCFS is consistent with current scientific knowledge and existing greenhouse gas accounting practices. It is also a prerequisite for recognizing any greenhouse gas benefit to biofuels produced either inside or outside of California.

Accordingly, the Court should affirm the State's use of best scientific practices to set meaningful climate policies by allowing California to consider the full lifecycle greenhouse gas emissions and to thereby reduce the expected harms from a changing climate.

Dated: June 15, 2012

Respectfully submitted,

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By:______________________________
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APPENDIX

APPENDIX — LIST OF *AMICI* AND THEIR BIOGRAPHIES

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Dr. W. Michael Hanemann

Dr. John Harte

Dr. Katharine Hayhoe

Dr. James C. McWilliams

Dr. Michael Oppenheimer

Dr. Terry Root

Dr. Richard Somerville

Dr. John M. Wallace

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