ORAL ARGUMENT NOT YET SCHEDULED

No. 19-1230

(Consolidated with 19-1239, 19-1241, 19-1242, 19-1243, 19-1245, 19-1246, 19-1249)

UNITED STATES COURT OF APPEALS FOR THE DISTRICT OF COLUMBIA CIRCUIT

UNION OF CONCERNED SCIENTISTS, et al.,

Petitioners,

v.

NATIONAL HIGHWAY TRAFFIC SAFETY ADMINISTRATION.

Respondent.

BRIEF OF CALIFORNIA CLIMATE SCIENTISTS IN SUPPORT OF PETITIONERS UNION OF CONCERNED SCIENTISTS, ET AL.

Deborah A. Sivas
Matthew J. Sanders
Daniel J. Irvin, Law Student Practitioner
ENVIRONMENTAL LAW CLINIC
Mills Legal Clinic at Stanford Law School
559 Nathan Abbott Way
Stanford, California 94305
(650) 723-0325
dsivas@stanford.edu

Counsel for Amici Curiae

CERTIFICATE AS TO PARTIES, RULINGS, RELATED CASES, AND SEPARATE BRIEFING

Pursuant to Circuit Rule 26.1, amici curiae state that they are seven individual academic professors with expertise in climate science and economics ("Climate Scientists") and are not corporations, associations, joint ventures, syndicates, or any other similar entities.

References to the rulings under review in these consolidated cases appear in the Brief of State and Local Government Petitioners and Public Interest Petitioners.

Pursuant to Circuit Rule 29(d), amici Climate Scientists state that they came together to submit a single brief addressing their collective expertise and that no other amicus brief, to their knowledge, will address this unique facet of the consolidated cases.

TABLE OF CONTENTS

TABLE OF AUTHORITIES iv

INTERESTS OF AMICI 1

SUMMARY OF ARGUMENT 1

ARGUMENT 5

I. California's Distinctive Topography, Natural Resources, and Demographic Patterns Render State Residents Particularly Vulnerable to Climate Change Impacts Caused by Greenhouse Gas Emissions 5

A. Climate change will increase wildfires in California. 5

B. Atmospheric rivers and changing precipitation patterns unique to the Pacific Coast put California at risk of severe flooding. 11

C. Rising atmospheric temperatures and precipitation deficits already prolong drought and will continue to do so. 15

D. Rising atmospheric temperatures will also melt Sierra Nevada snowpack and damage California's water supply 15

E. Climate change threatens California's unique agricultural sector 17

F. California's 1,100-mile coastline renders the state particularly vulnerable to the effects of sea-level rise. 19

G. Climate change exacerbates local smog, a problem that EPA has already deemed a "compelling and extraordinary condition" in California. 21

II. California's Advanced Clean Cars Program Is Necessary to Mitigate Local Air Pollution that EPA Has Long Recognized as a Compelling and Extraordinary Condition. 26

CONCLUSION 29

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INTERESTS OF AMICI

Amici are scientific experts who study the physical and economic effects of climate change on the people and places of California.[1] As such, they have an interest in sharing their expertise with the Court on technical issues relevant to California's climate policy decisions. In the rulemaking challenged by these consolidated cases, the U.S. Environmental Protection Agency (EPA) revoked California's long-standing "waiver" of preemption under section 209(b) of the Clean Air Act, 42 U.S.C. § 7543(b). That waiver has allowed California to target its climate policies at the unique conditions and vulnerabilities it faces as a geographically and demographically diverse state of nearly 40 million residents. In this brief, Amici explain how California's truly "compelling and extraordinary conditions" put its residents and resources at special risk from climate change.

SUMMARY OF ARGUMENT

The scientific consensus that the Earth's climate is warming and that human activity – primarily the burning of fossil fuels – is the primary cause for such warming is unequivocal. The Fifth Assessment of the Intergovernmental Panel on Climate Change concluded, with a confidence level of more than 95 percent, that

[1] Biographical information for Amici is set forth in the attached Appendix. Pursuant to Federal Rule of Appellate Procedure 29(a)(4)(E), the undersigned counsel represents that no party's counsel authored this brief in whole or in part and that no party, party's counsel, or other person funded any part of the preparation or submission of this brief.

over half of the observed global temperature increase during the last 60 years was caused by human activities.[2] As warming continues, the likelihood of severe impacts on human and natural systems increases – from rising sea levels that will flood coastal settlements[3] to disruptions of food systems[4] and much more. California is on the front line of these changes. Twice as many Californians live in high-risk wildfire zones as in the next most-affected state.[5] The state's water supply depends almost entirely on a snowpack that is highly vulnerable to climate change-induced drought and changes in precipitation.[6] California's agricultural

[2] IPCC 2013, CLIMATE CHANGE 2013: THE PHYSICAL SCIENCE BASIS. CONTRIBUTION OF WORKING GROUP I TO THE FIFTH ASSESSMENT REPORT OF THE INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE 17.

[3] See Phillip B. Duffy, et al., Strengthened Scientific Support for the Endangerment Finding for Atmospheric Greenhouse Gases, 363 SCI., 5 (2019) (projecting "a global average [sea level rise] rate unprecedented in the last 7000 years" that will put up to 13.1 million people at risk of inundation in the United States alone).

[4] See id. at 3 (explaining that "short periods of exposure to high growing-season temperatures" can cause crop losses and "warmer winter nights will also negatively affect perennial crops...that require a certain amount of winter chill for high yields").

[5] Susan I. Stewart, et al., The Wildland-Urban Interface in the United States, in USDA, THE PUBLIC AND WILDLAND FIRE MANAGEMENT: SOCIAL SCIENCE FINDINGS FOR MANAGERS 197, 199 (Sarah McCaffrey, ed., 2006).

[6] CALIFORNIA'S FOURTH CLIMATE ASSESSMENT STATEWIDE SUMMARY REPORT, 56-57 (2018), https://www.energy.ca.gov/sites/default/files/2019-11/Statewide_Reports-SUM-CCCA4-2018-013_Statewide_Summary_Report_ADA.pdf.

sector – the sole provider for many of the United States' specialty crops[7] – is imperiled by rising temperatures.[8] Over the last 125 years, Ventura County in Southern California, home to over 800,000 people, has experienced the largest increase in surface temperatures of any county in the continental United States.[9] Summer peak electricity demand in a warmer climate will require significant investments in new generation capacity.[10]

Responding to these imminent threats, California has adopted a suite of polices to mitigate anthropogenic sources of climate change, including the transportation regulations at issue in this litigation.[11] These policies are intended to reduce greenhouse gas emissions, drive the development of cost-effective new clean technologies, and provide global leadership on decarbonizing industrial society. In addition to reducing greenhouse gas emissions, California's transportation polices, such as the Zero Emissions Vehicle program, are intended

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[7] CAL. DEP'T OF FOOD & AGRIC., CALIFORNIA AGRICULTURAL STATISTICS REVIEW 2017-2018, 17-18 (2018).

[8] CALIFORNIA'S FOURTH CLIMATE ASSESSMENT, supra note 6 at 59.

[9] Scott Wilson, Fires, Floods and Free Parking: California's Unending Fight Against Climate Change, WASHINGTON POST (Dec. 5, 2019).

[10] Maximilian Auffhammer, et al. Climate Change Is Projected to Have Severe Impacts on the Frequency and Intensity of Peak Electricity Demand Across the United States, 114 PNAS 1886, 1891 (2017).

[11] See CAL. AIR RES. BD., CALIFORNIA'S 2017 CLIMATE CHANGE SCOPING PLAN ES1 (listing examples of California environmental policies).

to help meet EPA's National Ambient Air Quality Standards (NAAQS) for local criteria pollutants and will directly benefit the health of state residents.[12] For this very reason, EPA has routinely granted dozens of Clean Air Act waivers to California over the last several decades.[13]

Five years after granting a waiver for California's Advanced Clean Cars Program,[14] however, the National Highway Transportation Safety Administration (NHTSA) and EPA abruptly proposed revoking it.[15] In finalizing this proposal, the agencies reasoned that California does not "need" state greenhouse case and zero-emission-vehicle standards to meet "compelling and extraordinary conditions."[16] The agencies' reasoning belies reality and is inconsistent with a robust and growing body of research concerning the impacts of climate change and greenhouse gas pollution on California's communities and natural resources. Regardless of who bears the burden of showing "compelling and extraordinary conditions," the science demonstrates that this legal standard is satisfied. With its thousand-mile coastline, fire-prone ecosystems, mountainous topography, and

[12] Criteria Air Pollutants, U.S. EPA, https://www.epa.gov/criteria-air-pollutants (last visited Dec. 12, 2019).

[13] 74 Fed. Reg. 32,744, 32,745 (July 8, 2009).

[14] 78 Fed. Reg. 2112 (Jan. 9, 2013).

[15] 83 Fed. Reg. 42,986 (Aug. 24, 2018).

[16] 84 Fed. Reg. 51,310 (Sept. 27, 2019).

water-intensive agriculture, California already is suffering significant physical impacts from a warmer climate. Absent aggressive action under the waiver, these impacts will continue to worsen, threatening the lives and livelihoods of tens of millions of Americans.

ARGUMENT

I. California's Distinctive Topography, Natural Resources, and Demographic Patterns Render State Residents Particularly Vulnerable to Climate Change Impacts Caused by Greenhouse Gas Emissions.

A large and growing body of scientific evidence reveals that California is particularly susceptible to climate change and is, in fact, already experiencing harmful impacts from greenhouse gas emissions. These impacts include, among others, increasingly deadly wildfires, intensified flooding from "atmospheric river" storm events, prolonged drought, melting of the snowpack on which the state's water systems depend, reduced yield of nationally important food crops, rising sea levels along California's 1,100-mile coastline, and worsening local air pollution. While other communities may also face some of these threats, California's unique geography and population patterns combine to make the physical, social, and economic impacts of climate change especially devastating.

A. Climate change will increase wildfires in California.

Few natural disasters have grabbed as many headlines over the past several years as wildfires in California. The Camp Fire in 2018 – the most destructive wildfire in California history – burned 155,366 acres, destroyed 18,804 structures, and killed 85 people.[17] The town of Paradise was effectively destroyed by the fire, with roughly 90 percent of its homes burned to the ground.[18]

California is uniquely vulnerable to wildfires.[19] It is the only state in the country with a Mediterranean climate type.[20] Most of the California coastline, large parts of the Central Valley, the San Francisco Bay Area, and parts of Southern California all have variations of the Mediterranean climate type.[21] This climate is marked by a number of characteristics, including a short rainy season in the winter that allows significant plant growth, followed by dry summer and fall periods that turn the plant growth into available fuel.[22] As a result, ecosystems in the Mediterranean climate type – which are biodiversity "hotspots" that account for

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[17] Top 20 Deadliest California Wildfires, CAL. DEPT. OF FORESTRY & FIRE PROTECTION (Sept. 27, 2019) https://www.fire.ca.gov/media/5512/top20_deadliest.pdf.

[18] Kurtis Alexander, Reclaiming Paradise, SAN FRANCISCO CHRON., May 3, 2019.

[19] Scott L. Stephens, et al., Prehistoric Fire Area and Emissions from California's Forests, Woodlands, Shrublands and Grasslands, 251 FOREST ECOLOGY AND MGMT. 205, 205 (2007).

[20] Eric Kaufman, Climate and Topography, in ATLAS OF THE BIODIVERSITY OF CALIFORNIA 12, 12 (2003).

[21] See id. at 12; Yufang Jin, et al., Identification of two distinct fire regimes in Southern California: implications for economic impact and future change, 10 ENVIRONMENTAL RES. LETTERS 10 (2015) at 94005.

[22] Jon E. Keeley, Fire in Mediterranean Climate Ecosystems—a Comparative Overview, ISR. J. OF 58 ECOLOGY & EVOLUTION 123, 124 (2012).

roughly 20 percent of all plant species on Earth[23] – are highly fire-prone.[24] When chaparral shrublands are combined with hot and dry winds – like the offshore "Santa Ana" winds that periodically blow out of the desert and buffet coastal Southern California – the resulting fires can be devastating.[25]

Climate change will exacerbate the already-serious wildfire risk in California. A warmer climate will cause more water to evaporate from plants.[26] Combined with more variable precipitation, such evaporation means that California will face more frequent and severe droughts.[27] More droughts means more dead or dying plant matter that can serve as fuel for wildfires.[28] This

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[23] Jonathan Hughes, Mediterranean-Type Ecosystems, INT'L UNION FOR CONSERVATION OF NATURE, https://www.iucn.org/commissions/commission-ecosystem-management/our-work/cems-specialist-groups/mediterranean-type-ecosystems#:~:text=The%20world's%20five%20Mediterranean%2Dclimate,areas%2C%20the%20combined%20vascular%20plant, (last accessed June 14, 2020), see also KAREN J. ESLER, ET AL., THE BIOLOGY OF MEDITERRANEAN-TYPE ECOSYSTEMS (2018).

[24] Id. at 124-25.

[25] Max A. Moritz, et al., Spatial Variation in Extreme Winds Predicts Large Wildfire Locations in Chaparral Ecosystems, 37 GEOPHYSICAL RES. LETTERS L04801, 1 (2010).

[26] Anthony L. Westerling, WILDFIRE SIMULATIONS FOR THE FOURTH CALIFORNIA CLIMATE ASSESSMENT: PROJECTING CHANGES IN EXTREME WILDFIRE EVENTS WITH A WARMING CLIMATE 1 (2018).

[27] Id.

[28] Id.

phenomenon is already underway: The state's historic drought from 2012 to 2016 was intensified by climate change.[29]

As a result of the current and ongoing effects of climate change, the average annual area burned across the state is projected, under high greenhouse gas emission scenarios, to increase by approximately 77 percent; by the end of the century, the worst years for wildfires could see increases of more than 178 percent in burned area.[30] And Northern California forests could experience increases in burned areas of over 100 percent by 2085.[31] Of particular concern are increases in the size of high-severity fire patches, where greater than 90 percent of trees are killed.[32] At the macro scale, extreme fire events – those that burn more than 10,000 hectares – are expected to occur 50 percent more often over a 30-year scenario.[33] The threat of increased wildfires from climate change is no longer hypothetical: Climate change caused an estimated 4.2 million additional hectares

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[29] Patrick Gonzalez, et al., Ch. 25: Southwest, in CLIMATE CHANGE IMPACTS IN THE UNITED STATES: THE FOURTH NATIONAL CLIMATE ASSESSMENT 1101, 1105 (D.R. Reidmiller et al., eds. 2018).

[30] Westerling, supra note 26.

[31] Anthony L. Westerling, et al., Climate change and growth scenarios for California wildfire, 109 (suppl 1) CLIMATIC CHANGE 445, 457 (2011)

[32] Stephens et al., supra note 19 at 42.

[33] Westerling, supra note 26 at 1.

(10.4 million acres) of forest to burn from 1984 to 2015.[34] The combination of temperature increase and precipitation decrease already caused by climate change has doubled the number of autumn days where fire risk is at its highest.[35]

The projected impacts on California from this increase in wildfire risk are severe. The places most at risk from wildfire lie in the Wildland-Urban Interface – that is, "the area where houses and wildland vegetation meet or intermingle."[36] This risk is due to the proximity of structures to flammable vegetation, the difficulty of fighting fires at the urban edge, and the fact that most human-caused fires are started there.[37] The somber story of Paradise, which was located in the Wildland-Urban Interface,[38] is a warning sign. If a major wildfire sweeps through a community, the destruction can be nearly total.[39]

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[34] John T. Abatzoglou and A. Park Williams, Impact of Anthropogenic Climate Change on Wildfire across Western US Forest, 113 PNAS 11770, 11770 (2016).

[35] Michael Goss, et al., Climate change is increasing the risk of extreme wildfire conditions across California, ENVTL. RES. LETTERS, 2 (forthcoming 2020).

[36] Volker C. Radeloff, et al., Rapid Growth of the US wildland-urban interface raises wildfire risk, 115 PROC. AT THE NAT'L ACAD. OF SCI. 3314, 3314 (2018).

[37] Id.

[38] Matt Bussmann, Fires in Paradise: Exposure Growth and Catastrophe Risk in the Wildland-Urban Interface, RMS (Nov. 15. 2018) https://www.rms.com/blog/2018/11/15/fires-in-paradise-exposure-growth-and-catastrophe-risk-in-the-wildland-urban-interface/.

[39] See Alexander, supra note 18 (explaining that 90 percent of Paradise's residences were burned by the fire).

Roughly five million California homes sit at the Wildland-Urban Interface, almost twice as many as in the next most at-risk state.[40] One study of the home insurance market projected that in high-risk areas, the market share of insurers will drop by five percent, and insurance rates per $1,000 of coverage will rise by 18 percent.[41] Climate-driven shocks to insurance markets are no longer a theoretical problem: Near the end of 2019, California banned insurers from dropping customers in ZIP codes that were either struck by recent wildfires or adjacent to such ZIP codes.[42] The potential for insurers to drop customers in high-risk zones is serious, given that insurance payouts in 2017 and 2018 due to wildfires were double the industry's cumulative profits since 1991.[43] While state insurance regulations may provide a stop-gap measure, they cannot remedy the fundamental problem that California's wildfire risk is dramatically worsening and associated costs are dramatically rising for millions of homeowners.

The increase in severe wildfires, moreover, threatens more than residential structures and rural towns. It also puts at risk California's electricity system,

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[40] Stewart, et al., supra note 5, 197-99.

[41] Lloyd Dixon, et al., THE IMPACT OF CHANGING WILDFIRE RISK ON CALIFORNIA'S RESIDENTIAL INSURANCE MARKET vi (2018).

[42] Christopher Flavelle and Brad Plumer, California Bans Insurers from Dropping Policies Made Riskier by Climate Change, N.Y. TIMES (Dec. 5, 2019).

[43] Id.

particularly electrical transmission and distribution assets in Northern California, where critical power lines cross through highly fire-prone areas.[44] Increased and intensified wildfires also degrade air quality by producing large amounts of particulate matter hazardous to human health.[45] California's vulnerability to these extreme and worsening wildfire risks is truly extraordinary compared to any other state.

B. Atmospheric rivers and changing precipitation patterns unique to the Pacific Coast put California at risk of severe flooding.

California's largest floods have resulted from "atmospheric rivers" – narrow, intense bands of moist air that transport large quantities of water vapor towards Earth's poles and can cause extreme precipitation events. For instance, every declared flood on California's Russian River during the past 10 years has been tied to an atmospheric river.[46] Storms associated with atmospheric rivers have caused more than 99 percent of the flood damage in coastal California, Oregon, and Washington over the last 40 years.[47] Between 1978 and 2017, the ten most

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[44] Larry Dale, ASSESSING THE IMPACT OF WILDFIRES ON THE CALIFORNIA ELECTRICITY GRID iv (2018).

[45] Daniel J. Jacob and Darrel Winner., Effect of Climate Change on Air Quality, 43 Atmospheric Env't 51, 60 (2009).

[46] Michael Dettinger, Climate Change, Atmospheric Rivers, and Floods in California - A Multimodel Analysis of Storm Frequency and Magnitude Changes, 47 J. AM. WATER RES. ASS'N 514, 515 (2011).

[47] Thomas W. Corringham, et al., Atmospheric Rivers Drive Flood Damages in the Western United States, 5 SCI. ADVANCES 1, 3 (2019).

extreme atmospheric rivers caused $23 billion in flood damage – nearly half of all flood damage in the Western United States.[48]

Atmospheric rivers will become more powerful as the Earth warms. The effect is thermodynamic: As global temperatures increase, the atmosphere warms, causing the air to carry more water vapor, thereby intensifying atmospheric river storms.[49] According to a 2018 NASA study, global frequency of atmospheric river conditions, such as heavy rain and strong winds, will increase by 50 percent in a "business as usual" world.[50]

California's topography makes atmospheric river storms particularly intense. As atmospheric rivers approach the California coast, they typically exceed 2,000 kilometers in length but measure only a few hundred kilometers wide. In the absence of interactions with local topography (*i.e.*, mountain ranges), such filamentary bands transporting water vapor would simply continue on, mostly

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[48] Id.

[49] David A. Lavers, et al., Future Changes in Atmospheric Rivers and Their Implications for Winter Flooding in Britain, 8 ENVTL. RES. LETTERS 1, 7 (2013) ("[I]ncreasing [integrated vapor transport] in the future is largely due to increased moisture in the atmosphere, thus corroborating the sensitivity test that the increased [atmospheric river] frequency is thermodynamically driven.").

[50] Vicky Espinoza, et al., Global Analysis of Climate Change Projection Effects on Atmospheric Rivers, 45 Geophysical Res. Letters 4299, 4299 (2018); see also Esprit Smith, Climate Change May Lead to Bigger Atmospheric Rivers, NASA (May 24, 2018), https://climate.nasa.gov/news/2740/climate-change-may-lead-to-bigger-atmospheric-rivers/.

uninterrupted. But when the warm, moist air of these atmospheric rivers encounters California's mountain ranges, the air is forced upwards, causing vast amounts of water vapor to fall out as rain.[51] Thus, it is California's unique topographic features, rather than large-scale atmospheric dynamics affecting the entire continental United States, that renders atmospheric rivers so devastating to local communities within the state.[52]

Even "modest increases in [atmospheric river] intensity" will significantly exacerbate storm damage.[53] Atmospheric rivers are categorized like hurricanes, ranked from category 1 to category 5. With each increase above category 1, median damages increase by roughly an order of magnitude. That is, flood damages increase exponentially in relation to atmospheric river duration and intensity.[54] The upshot of climate change on atmospheric rivers is that the kinds of moderate atmospheric rivers that are beneficial – those that bring moderate rainfall,

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[51] This effect, where air is forced to rise and cool due to features such as hills or mountains, is known as orographic uplift. Cooling causes water vapor to form clouds, which then release water in the form of precipitation. *Orographic Uplift*, NAT'L WEATHER SERV, https://w1.weather.gov/glossary/index.php?word=orographic+uplift (last visited Dec. 9, 2019).

[52] Corringham et al., supra note 47 at 3.

[53] Id.

[54] Id.

recharge groundwater, and maintain snowpack[55] – will become less frequent, while extreme atmospheric river storms will become more common.

At the same time, California's floods are inseparable from the prolonged droughts that it experiences. Indeed, California's variation in precipitation is more extreme and unpredictable than any other state on the West Coast and the country as a whole.[56]

C. Rising atmospheric temperatures and precipitation deficits already prolong drought and will continue to do so.

Rising atmospheric temperatures make droughts more frequent and intense.[57] Historical evidence shows that California is more likely to experience

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[55] Atmospheric rivers may just as easily create conditions that melt snowpack quickly. For instance, in 2017, warm atmospheric rivers created conditions that caused the snowpack to melt quickly during the spring season. Hannah Fry, California Sees Biggest June Snowpack in Nearly a Decade Thanks to Spring Storms, L.A. Times (June 3, 2019), https://www.latimes.com/local/lanow/la-me-ln-large-sierra-snowpack-20190603-story.html.

[56] Michael D. Dettinger, Atmospheric Rivers as Drought Busters on the U.S. West Coast, 14 J. Hydrometeorology 1721, 1721 (2013); cf. Michael D. Dettinger, Historical and Future Relations Between Large Storms and Droughts in California, S.F. ESTUARY & WATERSHED SCI. 2 (July 2016) ("The state's surfeits (and, eventually, its floods) and droughts are actually inseparable, so that planning and management of floods and droughts may never be completely disentangled."); Tapan B. Pathak, et al., Climate Change Trends and Impacts on California Agriculture: A Detailed Review, 8 AGRONOMY 25, 25 (2018) ("The variability of precipitation in California is a unique phenomenon, implying that such unpredictability is more notable in the state than other parts of the West Coast and the country as a whole.")

[57] Noah S. Diffenbaugh, et al., Anthropogenic Warming Has Increased Drought Risk in California, 112 PNAS 3931, 3931 (2014).

drought when precipitation deficits coincide with warm conditions. In recent decades, these events have occurred more often, yielding more drought years.[58] Eighty percent of the years between 1995 and 2014 exhibited a positive temperature anomaly, as compared with just 45 percent for the longer period from 1896 to 2014.[59] The reason: anthropogenic warming caused by greenhouse gas emissions.[60] Indeed, climate change likely exacerbated California's historic drought from 2012 to 2016.[61] That period saw the lowest calendar year and 12-month precipitation totals in California's recorded history, as well as high temperatures.[62] As discussed below, this recent drought also illustrates how unusually warm temperatures and low snowpack can combine to diminish water availability in California's water system.

D. Rising atmospheric temperatures will also melt Sierra Nevada snowpack and damage California's water supply.

In addition to an increase in periods of drought, rising temperatures will harm California's water supply, which relies heavily on snowpack for seasonal

[58] Id.

[59] Id. at 3932.

[60] Id. ("The recent statewide warming clearly occurs in climate model simulations that include both natural and human forcings . . . but not in simulations that include only natural forcings ").

[61] Id. at 3935; Gonzalez, et al., supra note 29 at 1105.

[62] Diffenbaugh, et al., supra note 57 at 3931.

water storage.[63] Snowpack will decrease with air temperature warming, regardless of precipitation changes,[64] meaning that even if precipitation remains constant, California's water security will be harmed by climate change. The state's water availability depends largely on the mountain snowpack, in part because most precipitation occurs as snow during the cold season.[65] The winter Sierra Nevada snowpack then thaws throughout the spring and drains into reservoirs, where it supplies approximately 30 percent of California's annual water demand.[66] The state's water management systems, which make water available for aquatic ecosystems, agriculture, hydropower, and human consumption, have been built around the "natural reservoir" that California's snowpack provides.

Heat spells will likely induce earlier and faster-than-normal snowmelt. Under those circumstances, parts of California may experience severe flooding. Some projections suggest that under a high-warming scenario, California may

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[63] CALIFORNIA FOURTH CLIMATE ASSESSMENT, supra note 6 at 56.

[64] James H. Thorne, et al., The Magnitude and Spatial Patterns of Historical and Future Hydrologic Changes in California's Watersheds, 6 ECOSPHERE 1, 17 (2015); see also CALIFORNIA'S FOURTH CLIMATE ASSESSMENT, supra note 6 at 57 (citing Thorne).

[65] Moetasim Ashfaq, et al., Near-term Acceleration of Hydroclimatic Change in the Western U.S., 118 J. GEOPHYSICAL RES.: ATMOSPHERES 10,676, 10,676 (2013).

[66] Mike Kolian, The Importance of Snowpack, The EPA Blog (June 4, 2015), https://blog.epa.gov/2015/06/04/the-importance-of-snowpack/.

experience a 65 percent loss of snowpack by the end of the century.[67] Likewise, climate models predict that under various emissions scenarios, carryover storage – the volume of water available in reservoirs before the start of the wet season in late fall – in California's two largest reservoirs, Shasta and Oroville, will decline by about one-third by the end of the century.[68]

The impacts of drought and decreased snowpack on California communities cannot be overstated. California's people, economy, and natural systems rely on, and are integrally tethered to, a complex water storage and distribution network that stretches across the state.[69] Reductions in snowpack and river flow will require the state to invest in expensive new water resources.[70] Proposed alternatives like ocean water desalination have extremely high capital costs and energy requirements.[71]

E. Climate change threatens California's unique agricultural sector.

Changing climate conditions and impacts to water supply will also negatively affect food production in California.[72] Extreme heat waves will lower

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[67] Pathak, et al., supra note 56 at 31.

[68] CALIFORNIA'S FOURTH CLIMATE ASSESSMENT, supra note 6 at 57.

[69] Id. at 56.

[70] Gonzalez, et al., supra note 29 at 1112.

[71] Id.

[72] Pathak, et al., supra note 56 at 25.

crop yields; heat stress will increase water needs of crops and livestock; and hotter-than-normal temperatures will introduce new and changing pest and disease threats.[73] Temperatures in California are already at the upper threshold for corn and rice, meaning that any subsequent temperature increases will render these crops unviable.[74] Deficiencies in water supply are especially concerning because irrigated agriculture produces nearly 90 percent of the harvested crops in California.[75]

While other states with large agriculture sectors may also be harmed by climate change, California is unique two ways. First, it has the largest agriculture economy in the country – at $50 billion, the California agricultural sector is almost twice the size of the next largest state.[76] Second, California is unique in the crops it produces. One-third of U.S. vegetables and two-thirds of the country's fruits and nuts come from California.[77] The state is the leading exporter of 75 types of crops, including romaine lettuce, lemons, strawberries, and grapes.[78] And California is essentially the sole producer of 14 of these crops, including almonds, raisins,

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[73] CALIFORNIA FOURTH CLIMATE ASSESSMENT, supra note 6 at 59.

[74] Gonzalez, et al., supra note 29 at 1145.

[75] Pathak, et al., supra note 56 at 25.

[76] CAL. DEP'T OF FOOD & AGRIC., supra note 7 at 2.

[77] California Agricultural Production Statistics, CAL. DEP'T OF FOOD & AGRIC., https://www.cdfa.ca.gov/statistics/ (last visited Mar. 12, 2020).

[78] CAL. DEP'T OF FOOD & AGRIC., supra note 7 at 17.

garlic, olives and olive oil, and walnuts.[79] As climate change alters the water and temperature regimes for these crops, the effects could be devastating not only to California's agricultural economy, but also to the national food supply that depends on exports from California. Thus, even small declines in yield could cause large disruptions to the U.S. agricultural production sector, valued annually at $136.7 billion.[80]

F. California's 1,100-mile coastline renders the state particularly vulnerable to the effects of sea-level rise.

Sea levels have risen along the California coast, and there is broad scientific consensus that they will continue to do so. Over the 20th century, sea levels rose more than 15 cm (5.9 inches) along the Central and Southern California coast.[81] As a result, even moderate tides and storms have produced extreme high-water events. During a moderate storm in November 2015, for example, the La Jolla community enclave of San Diego reached its all-time highest sea level.[82]

There is no dispute that California is vulnerable to sea-level rise or that sea-level rise will likely cause severe economic disruption and damage to coastal

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[79] Id. at 18.

[80] Carolyn Olson, et al., Ch. 10: Agriculture and Rural Communities, in CLIMATE CHANGE IMPACTS IN THE UNITED STATES: THE FOURTH NATIONAL CLIMATE ASSESSMENT 391, 393 (D.R. Reidmiller et al. eds., 2018).

[81] CALIFORNIA FOURTH CLIMATE ASSESSMENT, supra note 6 at 31.

[82] Id. at 31.

residents. Roughly 26 million Californians live in a coastal county, the most in the nation.[83] Rising sea levels increase the frequency and probability of coastal inundation, or high-tide flooding.[84] Already, the erosion of cliffs and bluffs is rendering many coastal homes increasingly precarious and unsafe.[85] Eventually, high-tide flooding of homes, yards, roads, and business districts may render many coastal properties effectively unlivable.[86] Whole communities could ultimately be physically and financially lost to the sea.[87] State agencies and seaside towns like Del Mar in Southern California are, even now, engaged in heated debates over the merits and timing of a "managed retreat" strategy that would essentially surrender existing infrastructure to the rising tides.[88]

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[83] Economics and Demographics, NOAA OFFICE FOR COASTAL MANAGEMENT, https://coast.noaa.gov/states/fast-facts/economics-and-demographics.html (last visited Mar. 12, 2020).

[84] William V. Sweet & Joseph Park, From the Extreme to the Mean: Acceleration and Tipping Points of Coastal Inundation from Sea Level Rise, 2 EARTH'S FUTURE 579, 580 (2014).

[85] Rosanna Xia, The California coast is disappearing under the rising sea. Our choices are grim, L.A. TIMES, Jul. 7, 2019.

[86] UNION OF CONCERNED SCIENTISTS, UNDERWATER: RISING SEAS, CHRONIC FLOODS, AND THE IMPLICATIONS FOR US COASTAL REAL ESTATE 2 (2018).

[87] Id.

[88] Erik Anderson, Del Mar, California Coastal Commission Clash over Climate Change Plan, KPBS, https://www.kpbs.org/news/2019/oct/07/del-mar-and-coastal-commission-clash-climate-chang/ (Oct. 9, 2019); see also A.R. Siders et al., The Case for Strategic and Managed Retreat, 365 SCI. 761, 761 (2019) (explaining and arguing for strategic retreat).

Persistent coastal inundation will simultaneously erode iconic California beaches. Projections show that 31 to 67 percent of Southern California beaches may be completely lost by 2100, effectively eliminating their recreational and tourism value.[89] Corresponding damages could reach nearly $17.9 billion, and these costs would double in the event of a 100-year coastal flood.[90] In the worst-case scenarios, resultant flooding in Southern California could affect 250,000 people, $50 billion worth of property, and $39 billion worth of buildings.[91]

G. Climate change exacerbates local smog, a problem that EPA has already deemed a "compelling and extraordinary condition" in California.

California's topography, climate, and population size combine in such a way as to make state residents uniquely vulnerable to local air pollution, particularly photochemical "smog" (a combination of airborne particles and ground-level ozone). Smog is formed when nitrogen oxides and volatile organic compounds react to form ozone, which then combines with particulate pollution.[92] Nitrogen oxides and volatile organic compounds are produced when fossil fuel is burned in vehicles and power plants.[93] Because the reaction that forms ground-level ozone

[89] California Fourth Climate Assessment, supra note 6 at 9.

[90] Id. at 9.

[91] Id. at 9.

[92] Jacob and Winner., supra note 45 at 51.

[93] Id.

requires light, days with the most sun tend to have the most smog.[94] Hazardous concentrations of smog are most likely to form when meteorological and topographical conditions allow air pollutants to accumulate in stagnant air.[95] Thus, the ideal conditions for smog formation exist in locations with many internal combustion engines, frequent sunny days, and topographical/meteorological conditions that encourage air stagnation. California, with its large car-driving population, almost year-round sunny weather, and cities set in bowl-shaped depressions surrounded by mountains, presents perfect smog-forming conditions.[96]

Despite air-quality improvements over the last several decades, California continues to have the worst air quality in the country.[97] Los Angeles retains the dubious distinction of having the nation's very worst air quality, and seven of the nation's ten most ozone-polluted cities are located in California.[98] Bakersfield, in

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[94] Smog, NAT'L GEOGRAPHIC, https://www.nationalgeographic.org/encyclopedia/ smog/ (last visited Dec. 6, 2019).

[95] Daniel Horton, et al., Occurrence and Persistence of Future Atmospheric Stagnation Events, 4 NATURE CLIMATE CHANGE, 698, 698 (2014).

[96] Air Pollution a Problem in California?, CAL. AIR RES. BD., https://ww3.arb.ca.gov/knowzone/students/airpollu/airpolpage/whyis.htm (last visited Dec. 6, 2019).

[97] See 2019 State of the Air Report, AMERICAN LUNG ASS'N, at 7 (2019) ("California continues to dominate [the list of most-polluted cities], with six of the 10 most-polluted, and five of the seven cities that fail to meet the annual standard.").

[98] Id. at 6.

the southern San Joaquin Valley, has the worst particulate matter pollution in the nation.[99] Decades after passage of the Clean Air Act, many parts of California still have not attained EPA's mandatory limits on concentrations of surface-level ozone under the federal NAAQS program.[100]

Climate change will worsen climatic conditions that favor smog formation in two ways. First, higher temperatures promote ozone formation.[101] There is a long-documented link between temperature and ozone: The summer is the season with the greatest number of days when the ozone concentration exceeds air quality standards (each day is an "exceedance").[102] Likewise, hotter summers have more exceedances, with exceedances in hot summers eclipsing those in cold summers by as much as a factor of ten.[103]

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[99] Id. at 4.

[100] C.B. Zapata, et al., Low-carbon Energy Generates Public Health Savings in California, 18 ATMOSPHERE CHEMISTRY AND PHYSICS 4817, 4822 (2018); for an explanation of NAAQS, see NAAQS Table, U.S. EPA, https://www.epa.gov/criteria-air-pollutants/naaqs-table (last visited Dec. 12, 2019).

[101] L. Shen, et al., Impact of increasing heat waves on U.S. ozone episodes in the 2050s: Results from a multimodel analysis using extreme value theory, 43 GEOPHYSICAL RES. LETTERS 7 (2016).

[102] Jacob and Winner., supra note 45 at 52.

[103] Id. ("The summer of 1988 was the hottest on record in the Northeast and experienced a record high number of exceedances. The summer of 1992 was the coolest in the 1980–2006 record due to the eruption of Mt. Pinatubo and it had a low number of exceedances. The difference in the number of episodes between 1988 and 1992 in Fig. 1 is a factor of 10.") (emphasis added); William M. Cox &

Temperatures have already risen by a significant amount in Southern California, and climate change will exacerbate this phenomenon. Since 1895, Santa Barbara County has experienced an increase in average temperature of 2.3 degrees Celsius, and neighboring Ventura County has seen a similar rise of 2.6 degrees Celsius.[104] Ventura County's temperature increase is the largest of any county in the lower 48 states.[105] As carbon dioxide concentrations continue to rise, temperatures will climb further, increasing the number of days with dangerous concentrations of smog.[106]

The second way that climate change promotes smog formation is through an increase in stagnation events. Air stagnation events occur when "an air mass remains in place over a geographic region for an extended period of time."[107] These events are caused by a lack of wind and rain, both of which would serve to break up or move air masses.[108] Stagnation events facilitate the accumulation of pollutants in a single air mass in the near-surface atmosphere, close to emission

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Shao-Hang Chu, Assessment of Interannual Ozone Variation in Urban Areas from a Climatological Perspective, 30 ATMOSPHERIC ENV'T 2615, 2624 (1995).

[104] Wilson, supra note 9.

[105] Id.

[106] Shen, et al., supra note 101 at 7.

[107] Bob Yirka, New Study Suggests More and Longer Atmospheric Stagnation Events due to Global Warming, PHYS.ORG (June 23, 2014), https://phys.org/news/ 2014-06-longer-atmospheric-stagnation-events-due.html.

[108] Id.

sources.[109] A warming planet will make the global climate more stagnant "due to a weaker global circulation and a decreasing frequency of mid-latitude cyclones."[110] As a result, stagnation events are predicted to increase by up to 40 days in many areas, and impacts in the Western United States are expected to be particularly acute.[111]

Multiple studies spell out the consequence of a warming climate for local air pollution: "The climate penalty for ozone air quality implies the need for more stringent emission controls to attain a given air quality objective."[112] Study results showing increases in ground-level ozone episode days "point to the need for ambitious emissions controls to offset this penalty."[113] EPA has long recognized that California is uniquely exposed to air pollution,[114] as the state's ongoing local air quality problems attest.[115] Climate change will require even more stringent emissions controls just to prevent any further degradation in air quality. Rather than wait for that scenario, California has taken an affirmative approach to the

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[109] Horton, et al., supra note 95 at 698.

[110] Jacob and Winner., supra note 45 at 51

[111] Horton, et al., supra note 95 at 698.

[112] Jacob and Winner., supra note 45 at 60.

[113] Shen, et al., supra note 101 at 7.

[114] See e.g., 49 Fed. Reg. 18890 (May 3, 1985).

[115] See discussion, supra notes 96 - 100.

problem – attacking climate change head-on in the hope of avoiding even stricter emissions standards in the future.

II. California's Advanced Clean Cars Program Is Necessary to Mitigate Local Air Pollution that EPA Has Long Recognized as a Compelling and Extraordinary Condition.

Even if California residents were not peculiarly vulnerable to the myriad climate impacts discussed above, carbon emissions reductions from the transportation sector are necessary to ameliorate the state's continuing local air pollution violations, which will inevitably worsen as the climate warms. EPA has previously granted some 50 waivers to address the "compelling and extraordinary conditions" posed by California's localized air pollution problems,[116] yet the state still struggles to meet federal NAAQS requirements. By promoting lower-emissions and zero-emission vehicles, the regulations at issue here will reduce the emission of criteria air pollutants and facilitate substantial improvements in California's air quality.[117]

Although technologies like the catalytic converter have lowered emissions of

[116] 74 Fed. Reg. 32,744, 32,745 (July 8, 2009).

[117] See Zapata, et al., supra note 100 at 4828 (finding that "Measures to reduce GHG emissions to 80% below 1990 levels in California under the GHG-Step scenario altered emissions of criteria pollutants (or their precursors) that generally brought nearly all regions of California into compliance with the O3 NAAQS").

nitrogen oxides from gas-engine vehicles,[118] and significant advances have been made in reducing such emissions from diesel engines,[119] it is impossible to create an internal combustion engine that produces no oxides of nitrogen.[120] This fact, combined with California's population increase from 15.8 million in 1960 to 39.2 million in 2016,[121] makes clear that air quality improvements necessarily plateau when gasoline and diesel-powered vehicles constitute the dominant mode of transportation. For California to fully address its local air pollution conundrum, the state must implement vehicle emissions regulations that go to the heart of the problem by incentivizing the use of alternatives to internal combustion engines.

A significant reduction in greenhouse gas emissions from vehicles is integral to California's program for achieving local air quality standards.[122] One study

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[118] Vehicle NOx emissions: The basics, THE INT'L COUNCIL ON CLEAN TRANSP., (October 10, 2017) https://theicct.org/cards/stack/vehicle-nox-emissions-basics#1.

[119] Brian C. McDonald, Long-Term Trends in Motor Vehicle Emissions in U.S. Urban Areas, 47 ENVTL. SCI. & TECH. 10022, 10022 (2013).

[120] Vehicle NOx emissions: The basics, supra note 118.

[121] California State University Chancellor's Office, California named state with the worst air quality (again), SCIENCEDAILY (June 19, 2017) https://www.sciencedaily.com/releases/2017/06/170619092749.htm.

[122] See Advanced Clean Cars Program, CAL. AIR RES. BD., https://ww2.arb.ca.gov/ our-work/programs/advanced-clean-cars-program (last visited Dec. 6, 2019) ("CARB adopted a set of regulations to control emissions from passenger vehicles, collectively called Advanced Clean Cars…[it] combined the control of smog-causing (criteria) pollutants and greenhouse gas (GHG) emissions into a single coordinated package of regulations").

projected that California's adoption of technologies to achieve an 80 percent reduction (from 1990 greenhouse gas emissions levels) by 2050 would lead to NAAQS attainment in 19 of the 23 counties currently in violation of federal ozone standards and would reduce deaths associated with particulate air pollution.[123] That study concluded that strategies to reduce carbon emissions overlap with NAAQS objectives and will "produce air quality improvements that would otherwise be challenging or impossible to achieve" in the absence of decarbonization efforts.[124] Such local air quality improvements would reduce the air pollution-related mortality rate by 54 to 56 percent, yielding an estimated $11.4 to $20.4 billion in public health benefits.[125] Thus, even if no other jurisdiction takes action to reduce carbon emissions, California's regulations will produce significant public health benefits for millions of state residents.

California's greenhouse gas regulations also have important distributional benefits. While some assume that the location of greenhouse gas emissions does not matter because carbon dioxide is well mixed and has a long lifespan in the atmosphere, this assumption ignores the co-benefit of local air quality

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[123] Zapata, et al., supra note 100 at 4823, 4824-26.

[124] Id. at 4828.

[125] Id.

improvements.[126] These localized public health benefits are particularly significant and important for residents of low-income and minority communities in urban Los Angeles and rural southern San Joaquin Valley who have long been disproportionately burdened by poor air quality.

CONCLUSION

California is uniquely and particularly vulnerable to the impacts of climate change caused by greenhouse gas emissions. The state faces a devastating confluence of increasingly intense wildfires, declining food crop production, significant water system disruption, severe drought and flooding events, coastal community destruction, and deteriorating local air quality. Vehicle emissions are the greatest source of the problem: In 2017, the transportation sector generated 41 percent of California's greenhouse gas emissions, compared to 24 percent for the next largest sector.[127] Cleaner cars are key to addressing climate change and meeting local air quality standards. These "compelling and extraordinary conditions" drove California to adopt vehicle emissions policies to reduce the

[126] G. F. Nemet, et al., Implications of Incorporating Air-Quality Co-Benefits into Climate Change Policymaking, 5 ENVTL. RES. LETTERS 014007, 4 (2010).

[127] CAL. AIR RES. BD., CALIFORNIA GREENHOUSE GAS EMISSIONS FOR 2000 TO 2017 20.

state's carbon footprint and protect the physical security and well-being of its 40 million residents. The science supports the continuing need for those policies.

July 6, 2020

Respectfully submitted,

/s/ Daniel J. Irvin

Daniel J. Irvin, Student Practitioner
Deborah A. Sivas, Supervising Attorney
Matthew J. Sanders
ENVIRONMENTAL LAW CLINIC
Mills Legal Clinic at Stanford Law School
559 Nathan Abbott Way
Stanford, CA 94305
(650) 723-0325
dsivas@stanford.edu

Counsel for Amici Curiae

Appendix of Amici Biographical Information (Alphabetical)

David Dickinson Ackerly is the Dean of Rausser College of Natural Resources, and a Professor of Integrative Biology and Environmental Science, Policy, and Management, at the University of California, Berkeley. Dr. Ackerly received his undergraduate degree from Yale University magna cum laude and his PhD from Harvard University. He is a Fellow of the Ecological Society of America and the California Academy of Sciences, and the co-founder of the Terrestrial Biodiversity Climate Change Collaborative, a university-NGO partnership focused on climate change impacts and adaptation in northern California. Dr. Ackerly's research focuses on the impacts of climate change on biodiversity and natural ecosystems, and the adaptation strategies for natural resource conservation in the face of climate change. He has consulted frequently with NGOs and regional and state government and was the lead author of the Bay Area summary report for the California Fourth Climate Change Assessment.

Maximilian Auffhammer is the George Pardee Jr. Family Professor of International Sustainable Development at the University of California, Berkeley, where has been a professor in the Department of Agricultural & Resource Economics and the College of Letters and Sciences since 2003. Dr. Auffhammer currently serves as the Associate Dean of Interdisciplinary Social Sciences in the

College of Letters and Sciences, and the Regional Associate Dean in Social Sciences, Arts and Humanities and the Undergraduate Division. He is also a research associate at the Energy Institute at Haas, a Fellow of the CESifo network, and a research associate at the National Bureau of Economic Research as well as a Humboldt Fellow. Dr. Auffhammer's research areas include environmental and energy economics, climate economics, regulation, and forecasting, with a geographic area of expertise focused on California, among other places. He served as a lead author on the Fifth Assessment Report of the Intergovernmental Panel on Climate Change and was appointed to serve on a National Academies of Sciences Panel to assess the social cost of carbon.

Allen Goldstein is a Professor in the Department of Civil and Environmental Engineering and in the Department of Environmental Science, Policy, and Management at the University of California, Berkeley, where he joined the faculty in 1996. Professor Goldstein currently serves as Associate Dean for the UC Berkeley Rausser College of Natural Resources, and he previously served as co-Chair of the International Global Atmospheric Chemistry program (IGAC) from 2013-2016 and as the chair of his department from 2007 to 2010. Dr. Goldstein received his B.A. and B.S. degrees from the University of California, Santa Cruz in politics and chemistry, and his M.A. and Ph.D. degrees in chemistry from Harvard University. He has published more than 350 scientific papers related to air pollution and climate, and his honors include the American Geophysical Union Atmospheric Sciences Section Yoram J. Kaufman Unselfish Cooperation in Research Award (2019); the David Sinclair Award from the American Association for Aerosol Research (2018); and the Alexander von Humboldt Research Award in Germany (2017). He has also served as a Fulbright Senior Scholar in Italy (2018) and in Australia (2005), was elected a Fellow of the American Geophysical Union (2011) and of the American Association for the Advancement of Science (2018), and has been recognized as a Highly Cited Researcher by Clarivate Analytics (2017, 2018 & 2019, ranking in the top 1% Web of Science citations for the field).

John Harte is a Professor of the Graduate School at the University of California, Berkeley. Professor Harte has received a Guggenheim Fellowship, the Leo Szilard prize from the American Physical Society, and is a co-recipient of a 2006 George Polk award in investigative journalism. He is an elected Fellow of the California Academy of Sciences, the American Physical Society, the Ecological society of America, and the American Association for the Advancement of Science. He has also served on six National Academy of Sciences Committees and has authored over 240 scientific publications, including eight books, one of which, “Consider a Spherical Cow,” is a widely used textbook on environmental modeling. His research focuses on climate change, biodiversity, and maintaining ecosystem services for humanity. Dr. Harte completed his undergraduate studies at Harvard and his PhD at the University of Wisconsin.

David Sedlak is the Plato Malozemoff Professor in the Department of Civil & Environmental Engineering at the University of California at Berkeley. He is also the Co-Director of the Berkeley Water Center and Deputy Director of the NSF engineering research center for Reinventing the Nation's Urban Water Infrastructure (ReNUWIt). Dr. Sedlak has over 25 years of research experience studying water quality and the fate of chemicals in the environment. He has served on the USEPA's Science Advisory Board for Drinking Water as well as the State of California's Expert Advisory Panel for Direct Potable Water Reuse. He is a member of the US National Academy of Engineering and recipient of numerous awards. including the Paul Busch Award for Innovation in Applied Water Quality Research and the Clarke Prize for Excellence in Water Research. Dr. Sedlak is the author of *Water 4.0: The Past, Present and Future of the World's Most Vital Resource* and a member of the Water Science & Technology Board.

Scott Lewis Stephens is the Henry Vaux Distinguished Professor in Forest Policy and Professor of Forest Science at the University of California at Berkeley. His research focuses on wildland fire and ecosystems, including how management and climate change alter prehistoric interactions between fire and ecosystems and how wildland fire policy can be improved to meet the challenges of the next decades.

Dr. Stephens has frequently been invited to give testimony on wildfire and climate changes impacts at the White House and before Congress and the California State Legislature. He was a member of the Little hoover Commission that developed a state-wise plan for forest management in California and has published over 200 journal papers.

LeRoy Westerling is a Professor of Management of Complex Systems at the University of California at Merced. His research interests and publications are in applied climatology, climate-ecosystem-wildfire interactions, statistical modeling for seasonal forecasts, paleofire reconstructions, climate change impact assessments and resource management and policy. Professor is a graduate of UCLA and earned his PhD from UC San Diego.

CERTIFICATE OF COMPLIANCE

I certify that the foregoing brief is complies with the type-volume limitations of the Court's order filed May 20, 2020 (ECF Dkt No. 1843712) because, according to the Microsoft Word word-processing program on which it was created, it is proportionately spaced, has a Times New Roman typeface of 14 points, and contains 6,485 words, excluding those parts of the brief exempted under Federal Rule of Appellate Procedure 32(f) and Circuit Rule 32(e)(1).

<u>/s/ Deborah A. Sivas</u>
Deborah A. Sivas

CERTIFICATE OF SERVICE

I hereby certify that, on July 6, 2020, I electronically filed the foregoing with the Clerk of the Court for the United States Court of Appeals for the District of Columbia Circuit using the appellate CM/ECF system, which served a copy of the document on all counsel of record in the case.

Respectfully submitted,

/s/Deborah A. Sivas

Deborah A. Sivas
Matthew J. Sanders
ENVIRONMENTAL LAW CLINIC
Mills Legal Clinic at Stanford Law School
559 Nathan Abbott Way
Stanford, CA 94305
(650) 723-0325
dsivas@stanford.edu

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Counsel for Amici Curiae