Exhibit A

Brief of Amicus Curiae James Hansen

DANIEL M. GALPERN (*Pro Hac Vice Pending*)
Western Environmental Law Center
1216 Lincoln Street
Eugene, OR 97401
T: (541) 359-3243 / F: (541) 485-2457
Email: galpern@westernlaw.org

PAIGE M. TOMASELLI State Bar No. 237737
Center for Food Safety
303 Sacramento St., 2nd Floor
San Francisco, CA 94111
T: (415) 826-2770 / F: (415) 826-0507
Emails: ptomaselli@icta.org

Counsel for Amicus Curiae

UNITED STATES DISTRICT COURT
FOR THE NORTHERN DISTRICT OF CALIFORNIA
SAN FRANCISCO DIVISION

ALEC L., *et al.*, Plaintiffs, vs. LISA JACKSON, *et al.*, Defendants.	Case No.: 4:11-cv-02203 EMC Brief for Amicus Curiae Dr. James Hansen (Hon. Edward M. Chen)

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INTEREST AND IDENTITY OF *AMICUS CURIAE* JAMES HANSEN

Amicus Curiae James Hansen, Ph.D., appears here in his individual capacity and not as a representative of any institution with which he is affiliated. The information and opinions in this brief are not necessarily those of any institution with which he is affiliated or those of any party to the present litigation. This brief is offered as an aid to the Court's deliberations over whether the relief sought by plaintiffs in their motion for preliminary injunction is needed to preserve a climate system that is conducive to the survival and wellbeing of our children and their progeny.

Dr. James Hansen directs the NASA Goddard Institute for Space Studies in New York City and is an Adjunct Professor of Earth Sciences at Columbia University's Earth Institute. He was trained in physics and astronomy in the space science program of Dr. James Van Allen at the University of Iowa, receiving his Ph. D. in physics in 1967. Since the mid-1970s, Dr. Hansen has focused on computer simulations and studies of the Earth's climate, for the purpose of understanding the human impact on global climate. Dr. Hansen's testimony to Congress in the 1980s helped raise broad awareness of the global warming issue. In recent years Dr. Hansen has drawn attention to the danger of passing climate tipping points, producing irreversible climate impacts that would yield a different planet from the one on which civilization developed. As part of his work in recent years, Dr. Hansen has outlined steps that are needed to stabilize climate, with a cleaner atmosphere and ocean.

Dr. Hansen was elected to the National Academy of Sciences in 1995.

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SUMMARY OF ARGUMENT

Global warming due to emissions of greenhouse gases, mainly CO_2 from fossil fuel consumption, is already 0.8°C, and a similar or greater amount is "in the pipeline" without any further change of atmospheric composition. Already-observed impacts of this warming include rising sea levels, increased atmospheric moisture resulting in more intense precipitation events, higher temperatures causing more frequent and intense heat waves and droughts, loss of sea ice, ice sheet mass and glaciers, expansion of the subtropics, acidification of the oceans, shifting distributions of plant and animal species, and an increasing rate of species extinctions.

Maintaining a climate that resembles the Holocene epoch, the world of a relatively stable climate system under which civilization developed, requires rapid reduction of fossil fuel CO_2 emissions and reforestation. Atmospheric CO_2 concentrations passed the level that is estimated to be safe on the long term in, approximately, 1988; global mean temperature now exceeds the Holocene peak; and unabated fossil fuel emissions continue to drive the Earth increasingly out of energy balance. Unless action is undertaken without further delay, so as to return the atmospheric concentration of CO_2 to 350ppm by 2100, Earth's climate system will be pressed toward and past points of no return. Effective action remains possible, but delay in undertaking sharp reductions in emissions will undermine any realistic chance of preserving a habitable climate system -- needed by future generations no less than by prior generations.

Plaintiffs in this case seek a preliminary injunction to ensure that Defendants in this matter submit to the Court a plan to preserve the climate system, including a cap on CO_2 emissions at 2011 levels by 2013, and emissions reductions thereafter by a minimum of 6% annually. That prescription is consistent with scientific understanding of what is minimally needed to avert truly dangerous climate change and preserve the physical status quo of a habitable climate system. In light of the fossil fuel industry's stranglehold of Congress, the President's demonstrated disinclination to utilize his authority to act, and the fact that further delay vastly increases the risk of irretrievable damage to the climate system, action by this Court now is essential.

ARGUMENT

I. INTRODUCTION: THE RELEVANT STATUS QUO IS AN ATMOSPHERE THAT ENSURES A HABITABLE CLIMATE SYSTEM.

Plaintiffs and Defendants both appeal to the Court to preserve the "status quo." Pl's Mot'n for Prelim. Inj at 10; Def. Opp'n to Pl. Mot'n for Prelim. Inj. at 9. Amicus James Hansen also seeks to preserve the status quo; accordingly, this brief begins with an explanation as to what this implies for the global climate system.

Paleoclimate research conducted by Dr. Hansen and others establishes that for most of the Holocene period – the period of the most recent 10,000 years – Earth's climate, though highly variable on a regional basis, has been characterized by reasonably constant mean global temperatures. James Hansen et al., The Case for Young People and Nature: A Path to a Healthy, Natural, Prosperous Future (attached hereto as Exhibit 1) at 6.[1] This constancy enabled the Greenland and Antarctic ice sheets to remain in near mass balance, sea levels to be relatively stable, species to diversify, and civilization to develop.

Largely due to the burning of fossil fuels, the atmospheric CO_2 concentration has climbed sharply in recent decades – from 316ppm in 1959 to 390ppm in 2010.[2] In that period, US CO_2 emissions more than doubled, from 2.83 to 5.67 billion metric tons.[3] The CO_2 concentration is now to a level not seen on Earth for at least 3 million years. Exhibit 1 at 6. The CO_2 increment functions as an added blanket on the planet, reducing the amount of heat that would otherwise be re-radiated to space and throwing the planet into energy imbalance. In response, Earth has warmed by approximately 0.8°C over the last century, likely exceeding the prior Holocene peak.

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[1] *See also*, James Hansen and Makiko Sato, Paleoclimate Implications for Human-Made Climate Change 8-14 (2011).

[2] Mauna Loa CO_2 annual mean data from http://www.esrl.noaa.gov/gmd/ccgg/trends/.

[3] Carbon Dioxide Information Analysis Center (CDIAC), National CO_2 Emissions from Fossil-Fuel Burning, Cement Manufacture, and Gas Flaring: 1751-2008, http://cdiac.ornl.gov/ftp/trends/emissions/usa.dat. The text of this amicus brief here provides the data in units of CO_2 by utilizing the CDIAC's carbon-to-CO_2 conversion factor of 3.667.

Exhibit 1 at 7-8. The already apparent impact of this warming is reviewed in the next section. Due to Earth's thermal inertia, a similar or greater amount of additional 2.0°C warming is "in the pipeline" before Earth reaches energy balance at the present level of atmospheric CO_2 concentration.[4]

Avoidance of climate tipping points and subsequent points of no return[5] requires effective action to return the atmospheric CO_2 concentration to approximately 350ppm by the end of the century. *Exhibit 1* at 8. This would allow additional heat radiation to escape to space so as to restore the planet's energy balance without additional prolonged global warming. *Id.* Such action could stabilize Earth's climate system and mitigate human suffering, but further delay may doom this prospect.

The relevant status quo with respect to the present litigation, therefore, is an atmosphere whose composition of greenhouse gases ensures a relatively stable climate system conducive to the survival and well being of humanity and nature. This requires, then, action to restore the atmospheric CO_2 concentration to no more than 350ppm. In that we have currently overshot this safe atmospheric concentration level, as discussed *infra*, failure to act with all deliberate speed in the face of the clear scientific evidence of the danger[6] functionally becomes a decision to eliminate the option of preserving a habitable climate system.

II. GLOBAL WARMING HAS ALREADY REACHED THE DANGEROUS LEVEL AND, WITHOUT EFFECTIVE ACTION, WILL PRODUCE CATASTROPHIC AND IRRETRIEVABLE LOSSES.

Global climate change does not present merely "the possibility of some remote future injury." Def. Opp'n to Pl. Motion for Prelim. Inj at 9. Instead, it is a phenomenon that is already undermining human and natural systems, causing loss of life, and pressing species to extinction.

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[4] Hansen et al, Target Atmospheric CO_2: Where Should Humanity Aim?, hereinafter referred to as "Target CO_2," 225, The Open Atmospheric Science Journal (2008).

[5] *Id.*

[6] J. Hansen et al., Dangerous human-made interference with climate, Atmos. Chem. Phys., 7, 2287, 2308 (2007)

Unless arrested by effective action, climate change will produce calamitous consequences for humanity and nature alike, as tipping points are reached and points of no return are crossed.[7] Present and future impacts are addressed in turn.

(a) Present Impacts

While, as noted, global warming to date measures 0.8°C above the 1880-1920 period,[8] it has already led to a 40 percent reduction and an accelerating downward trend in summer Arctic sea ice cover, and an even faster decline in its thickness. *Exhibit 1* at 4. Continental ice sheets of Greenland and Antarctica have begun to shed ice at a rate of several hundred cubic kilometers per year. *Id.* In the past decade, sea level increased about 3cm—a rate of about one foot per century, and nearly twice as fast as the rate of increase during the preceding century.[9] This rise has resulted in losses of coastal wetland areas and greater levels of damage from coastal flooding.[10] For example, in the United States, increased sea level has led to the loss of 1900 square miles of coastal wetland in Louisiana, which in turn exacerbates the area's vulnerability to storm surges like Hurricane Katrina.[11] Mountain glaciers, the source of fresh water to major world rivers during the dry season, are receding rapidly all around the world. *Exhibit 1* at 4. In 1850, Glacier National Park in Montana had 150 glaciers measuring larger than twenty-five acres—today, it has just twenty-five.[12]

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[7] Hansen, et al define "the tipping level [as] the global climate forcing that, if long maintained, gives rise to a specific consequence [and] the point of no return [as] a climate state beyond which the consequence is inevitable, even if climate forcings are reduced. Target CO_2 at 225.

[8] The 1880-1920 period is the earliest time at which instrumental data allows accurate specification of global temperature, and the temperature in that period is estimated to be close to pre-industrial temperature averaged over several centuries.

[9] Decl. James Hansen at ¶ 40, 2006 WL 4761053 (D. Vt. 2006).

[10] INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE, 2007: IMPACTS, ADAPTATION, AND VULNERABILITY, Table 4.1 (hereinafter "IPCC Working Group II").

[11] U.S. Global Change Research Program, 2009: *Global Climate Change Impacts in the United States*, T. Karl, J.M. Melillo, T.C. Peterson (eds.), Cambridge Univ. Press.

[12] Brief of Amici Curiae Climate Scientists James Hansen et al., *Chamber of Commerce of the United States v. EPA*, 2010 WL __ (*citing to* U.S. Geological Survey, *Melting Glaciers Signal Change in National Parks,* http://www.nwrc.usgs.gov/world/content/land5.html).

Tropospheric water vapor and heavy precipitation events have increased. Droughts are more common, especially in the tropics and subtropics. *Exhibit 1* at 4. Coral reef ecosystems are being impacted by a combination of ocean warming and acidification from rising atmospheric CO_2, resulting in a 1-2% per year decline in geographic extent. *Exhibit 1* at 4. World health experts have concluded with "very high confidence" that climate change already contributes to the global burden of disease and premature death with altered distribution of some infectious disease vectors.[13] Subtropical climate belts have expanded, contributing to more intense droughts, summer heat waves, and devastating wildfires in the southern United States, the Mediterranean and Middle East regions, and Australia. *Exhibit 1* at 4. Mega-heat waves have become noticeably more frequent, including the 2010 heat wave in Moscow and in Texas in 2011. *Exhibit 1* at 4. It is nearly certain that such "outlier" heat events would not have occurred in the absence of global warming.[14]

(b) Future effects

Scientific prediction of long-term impacts from climate change is imprecise in part because of uncertainty about the relative speed with which amplifying feedbacks, including disintegration of Earth's major ice sheets, will occur. *Exhibit 1* at 13. Citing the Paleoclimate record, Dr. Hansen and colleagues noted the following most recently:

> Precise consequences of continuing [business as usual] emissions for several decades are difficult to define, because Earth has never experienced such a large rapid increase of climate forcings as would occur with burning of most fossil fuels this century. The closest analogy in Earth's history is probably the PETM (Paleocene-Eocene Thermal Maximum) in which rapid global warming of at least 5°C occurred. The PETM warming spike occurred in conjunction with injection of 3000-5000 GtC of carbon into the surface climate system during two 1-2 thousand year intervals separated by several thousand years. It is often assumed that the carbon originated from melting of methane hydrates, because of the absence of other known sources of that magnitude. PETM occurred during a 10-million year period of slow global warming, and thus methane release might have been a feedback magnifying that warming.
>
> The PETM witnessed extinction of about half of small shelled deep ocean

[13] IPCC Working Group II.

[14] J. Hansen, M. Sato, R. Ruedy, Climate Variability and Climate Change: The New Climate Dice, Nov. 10, 2011.

> animals that serve as a biological indicator for ocean life in general, but, unlike several other large warming events in Earth's history, there was little extinction of land plants and animals. An important point is that the magnitude of the PETM carbon injection and warming is comparable to what will occur if humanity burns most of the fossil fuels, but the human-made warming is occurring 10-100 times faster. The ability of life on Earth today to sustain a climate shock comparable to the PETM but occurring 10-100 times faster is highly problematic. Climate zones would be shifting much faster than species have ever faced. Thus if humanity burns most of the fossil fuels, Earth, and all species residing on it, will be pushed into uncharted climate change territory.

Exhibit 1 at 13 (internal citations omitted).

Based on measurements of observed climate change, computer simulations of the climate system's responses to additional CO_2 emissions, as well as information from the paleoclimate record, Dr. Hansen and others have concluded that continued burning over several decades of fossil fuels renders multi-meter sea level rise "practically certain," and create cause "millions of global warming refugees from highly populated low-lying areas . . . throwing existing global demographics into chaos." *Exhibit 1* at 14 (internal citations omitted).

These researchers note, as well, that acidification stemming from ocean uptake of a portion of increased atmospheric CO_2 is expected to increasingly disrupt coral reef ecosystem health, with potentially devastating impacts to certain nations and communities. *Exhibit 1* at 16. Hansen and others warn of receding mountain glaciers "with effects on seasonal freshwater availability of major rivers," *Exhibit 1* at 4, illustrating that present atmospheric CO_2 leves are "already a threat for future fresh water security." *Id.* at 16.

Increased concentration of CO_2 and associated increased global temperatures will deepen impacts on human health, with children being especially vulnerable. *Exhibit 1* at 16. Climate threats to health move through various pathways, especially by placing additional stress on the availability of food, clean air, and clean water. *Exhibit 1* at 16 (*citing to* Bernstein and Myers, *Climate Change and Children's Health*, Current Opin. Pediatrics, 23, 221-226 (2011)). Other principle climate-related impacts on human health include heat waves, asthma and allergies, infectious disease spread, drought, pests and disease spread across taxa: forests, crops and marine life, and winter weather anomalies. *Exhibit 1* at 18 (Table 1).

As noted *supra*, climate zones are already shifting at rates that exceed natural rates of change; this trend will continue as long as the planet is out of energy balance, a conclusion "based on comparison of the observed trend with inter-decadal variability in climate simulations."[15] Dr. Hansen and others note that "as the shift of climate zones becomes comparable to the range of some species, the less mobile species will be driven to extinction." *Exhibit 1* at 15. In 2007, the Intergovernmental Panel on Climate Change (IPCC) summarized studies estimating species extinctions from additional global warming and estimated[16] that for global warming of 1.6°C or more, relative to pre-industrial levels, 9-31 percent of species will be driven to extinction, while with global warming of 2.9°C, an estimated 21-52 percent of species will be driven to extinction.[17]

III. ACTION TO PHASE OUT CO_2 EMISSIONS IS URGENTLY REQUIRED, WHILE DELAY VIRTUALLY ENSURES CALAMITY.

The 2007 consensus statement by the IPCC, summarizing research through 2005, indicated that human-induced warming of Earth of approximately 2°C constituted dangerous climate change. From that, however, no conclusion logically could be drawn as to the danger inherent in lower levels of global warming.

Research by Dr. Hansen and others to assess this question has been spurred on by the realization, as described *supra*, that large climate impacts have commenced already, even though Earth's lagged temperature response to the recent climb in atmospheric CO_2 is only 0.75°C above preindustrial levels. Hansen et al estimate that this warming is already at least 0.25°C above the prior Holocene maximum. *Exhibit 1* at 5. Empirical research showing an ongoing and

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[15] Hansen, J., M. Sato, R. Ruedy, *et al.,* 2007b: Dangerous human-made interference with climate: a GISS modelE study, *Atmos. Chem. & Phys.*, 7, 2287-2312.

[16] IPCC Working Group II.

[17] Hansen et al note that "mass extinctions have occurred in conjunction with rapid climate change during Earth's long history. While new species evolved over hundreds of thousands and millions of years, such time scales are almost beyond human comprehension. Accordingly, if we drive many species to extinction we will leave a more desolate planet for our children, grandchildren, and as many generations as we can imagine." *Exhibit 1* at 15.

accelerating mass loss of the Greenland and West Antarctic ice sheets, which began within the last few decades, provides strong confirmation that today's global temperature has reached a level higher than prior Holocene temperatures. *Id.*

Accordingly, the best available current science establishes that today's global temperature is already close to or into the "dangerous zone." *Exhibit 1* at 106. Because the recently-observed climate effects with respect to the ice sheets are still relatively small compared to total ice sheet mass, these feedbacks may not be a major factor if maximum global warming overshoot of ~1°C occurs only briefly and then recedes. *Exhibit 1* at 10-12.

Action therefore must be undertaken to restore the atmosphere's safe level of CO_2 concentration to 350ppm, so as to avert any avoidable additional warming that may drive the climate system past tipping points "that assure transition to a very different planet," *Id.* at 12, and keep the period of overshoot to an absolute minimum.

Two underlying reasons that such action must be undertaken without further delay is indicated in Amicus Hansen's most recent research, summarized here, and illustrated in Fig. 1 *infra*. First, a substantial share of any additional infusion of CO_2 lasts in the atmosphere for centuries (and while there, continuously acts to further heat the planet). Accordingly, Earth's temperature response to the "radiative forcing" effect of the higher atmospheric CO_2 concentration is a function not only of recent emissions, but the persisting share of prior emissions. Second, as a consequence of the long-lived nature of CO_2 and the fact that human-derived emissions have already cause a substantial overshoot of the long-term safe atmospheric concentration level, any substantial delay in undertaking effective action – even if such action compelled a sharp cut-off of emissions – would render it impossible to return the atmospheric CO_2 concentration to 350ppm within this century. Thus, as illustrated in Fig. 1b, if emissions of CO_2 are allowed per business as usual for even two decades longer the concentration of CO_2 in the atmosphere will not return, until the year 2150, to the nominally safe level of 350ppm even if

all such emissions were abruptly ceased in the year 2030.[18] In contrast, complete cessation in 2011 would return to the atmospheric CO_2 concentration to 350ppm by mid-century. *Exhibit 1* at 9.

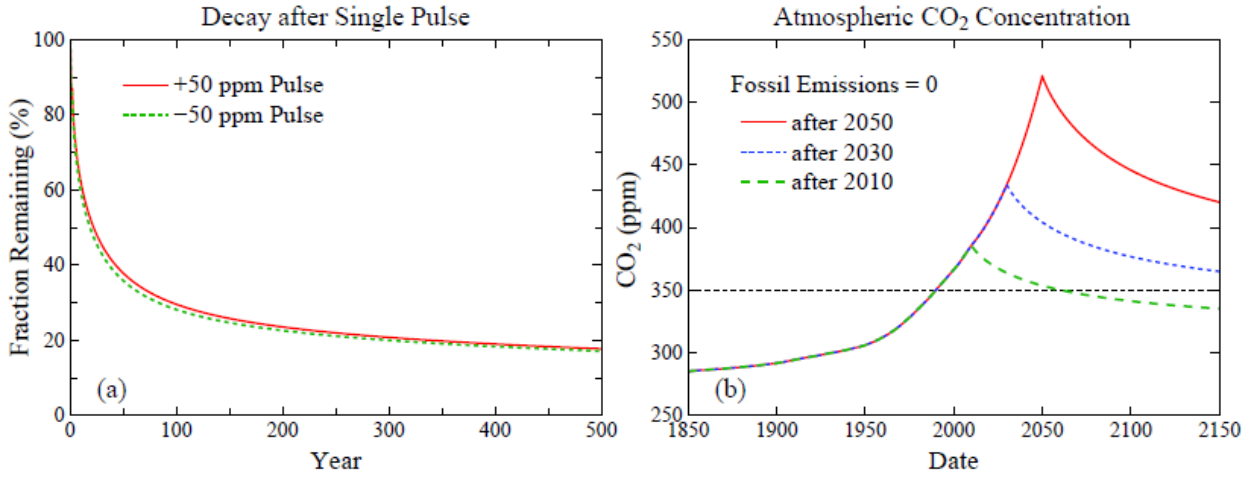

Figure 1. (a) Decay of instantaneous (pulse) injection and extraction of atmospheric CO_2, (b) CO_2 amount if fossil fuel emissions are suddenly terminated at the end of 2010, 2030, 2050. (Hansen et al., The Case for Young People and Nature: A Path to a Health, Natural, Prosperous Future.)

An abrupt cessation of all CO_2, whether in 2011 or 2030, is unrealistic, in part because industry, other business, and consumers alike need time to retool and reinvest in emission-free options to fossil fuels. Accordingly, Hansen et al have proposed a glide path to secure an atmosphere whose CO_2 concentration is no higher that 350ppm. Their plan requires emission reductions of 6 percent annually, coupled with a program of reforestation. *Exhibit 1* at 10. This will achieve the goal of restoring the atmosphere to approximately 350ppm if the plan is commenced without delay, and then adhered to. However, consistent with the abrupt phase out scenarios discussed in the prior paragraph *supra*, if the 6 percent annual emission reductions are delayed until 2030, then the global temperature will remain above 1°C higher than preindustrial

[18] *Exhibit 1* at 9. Further, were the emission cessation to commence only after 40 years, Dr. Hansen estimates that the atmosphere would not return to 350ppm CO_2 for nearly a 1000 years. *Id.*

levels for nearly 300 years. It would be "highly unlikely," that the planet's major ice sheets would remain "stable at their present size with such long-lasting warmth." *Exhibit 1* at 12-13.

Considered in another way, the required rate of emissions reduction would have been about 3.5% per year if reductions had started in 2005, while the required rate of reduction, if commenced in 2020, will be approximately 15% per year. *Id.* at 6. This illustrates, again, that "the dominant factor, by far, is the date at which fossil fuel emission phase-out begins." *Id.* at 11.

The present danger and impending calamities presented by continued CO_2 emissions, and the urgent need to get beyond fossil fuels before Earth is altered in fundamental respects – including its ability to sustain civilization – renders it a first-order tragedy that all serious attempts to address the problem in Congress to date either have been still-borne or killed after some debate. Equally tragic, the executive branch, including our current president, has declined to act with any degree of effectiveness to restrict CO_2 and other greenhouse gas emissions from the largest sources – bowing to industry pressure at virtually every turn even though, pursuant to the Supreme Court's leading global warming decision, *Mass. v. EPA*, 549 U.S. 497 (2007), it retains authority to act. The "absence of effective leadership" is attributable, as Amicus Hansen points out, to the "undue sway of special financial interests on government policies."[19] In the absence of political leadership, an Order by this Court granting the injunctive relief sought by plaintiffs in this matter may be the best, the last, and, at this late stage, the only real chance to preserve and restore the atmosphere and climate system.

CONCLUSION

Systematic reductions in CO_2 emissions, for the reasons provided by Dr. Hansen in his work cited throughout this amicus brief, must be undertaken in conjunction with reforestation so as to return the concentration of CO_2 in the atmospheric to a level no higher than 350ppm by the end of the century, if not sooner. Plaintiffs in this matter seek an Order by the Court to require Defendants to submit a "Climate Recovery Plan" by next March whose key features, if followed,

[19] *Exhibit 1* at 10 (citing to Oreskes, N.; Conway, E.M., 2010: Merchants of Doubt: How a Handful of Scientists Obscured the Truth on Issues from Tobacco Smoke to Global Warming. Bloomsbury Press, 355 pp. merchantsofdoubt.org.).

will restore the atmosphere and preserve a habitable climate system. This brief has established that such action is urgently required. In particular, the failure to commence CO_2 reductions without further delay, and to undertake other measures consistent with the prescription developed by Dr. Hansen and others, and advanced in these proceedings by Plaintiffs, would consign our children and their progeny to a very different planet, one far less conducive to their survival.

Respectfully submitted this 14th day of November, 2011.

/s/

Daniel M. Galpern
Western Environmental Law Center
1216 Lincoln Street
Eugene, OR 97401
T: (541) 359-3243 / F: (541) 485-2457
Email: galpern@westernlaw.org

PAIGE M. TOMASELLI State Bar No. 237737
Center for Food Safety
303 Sacramento Street, 2nd Floor
San Francisco, CA 94111
T: (415) 826-2770 / F: (415) 826-0507
Email: ptomaselli@icta.org

Counsel for Amicus