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Subject: Proceedings of February Workshop on Emerging Areas of Science, Engineering, and Medicine for the Courts
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Good Afternoon,

We are finalizing the text of the proceedings of the February workshop on Emerging Areas of Science, Engineering, and Medicine for the Courts. We would like to give you the opportunity to review our summary of your remarks prior to publication.

Would you kindly review your remarks as presented in the attached document and let me know by next Friday (June 11, 2021) whether you would like us to make any amendments in: 1) the text summarizing your formal presentation; and 2) the presentation of your comments in the discussion section at the end of the document?

Many thanks for your time, and thanks again for your participation in the workshop.

Regards,
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EMERGING ISSUES IN THE CLIMATE AND ENVIRONMENTAL SCIENCES

Session moderator **Paul Hanle** (Environmental Law Institute) introduced the session by raising questions about what a reference manual on scientific evidence should say about climate science,¹ what criteria should be used for selecting material to include in the manual, and what judges need to know in order to weigh evidence in cases that involve climate science. Hanle suggested that climate science is moving fast by historical standards. He said that legal issues often turn on climate impacts and that attribution is of central importance.

Hanle noted that two years ago there were approximately 1,000 climate-related cases pending in U.S. courts, but that today the number is over 1,300. He said that many have to do with government action – meeting requirements of the National Environmental Policy Act and the Clean Air Act, for example – but that a smaller but increasing number of tort complaints have been filed alleging nuisance, negligence, or consumer fraud by fossil fuel enterprises. He noted that, while most judges have not yet presided over any climate-related cases, many judges say they expect to see cases soon as their number grows.

The panel's first speaker, **Joellen L. Russell** (University of Arizona), began her presentation by speaking about carbon dioxide (CO₂), the way it is measured and regulated, and how we can deal with carbon accounting. She discussed the importance of the 2007 Supreme Court decision in

¹ “Climate science investigates the structure and dynamics of earth’s climate system. It seeks to understand how global, regional and local climates are maintained as well as the processes by which they change over time. In doing so, it employs observations and theory from a variety of domains, including meteorology, oceanography, physics,” and chemistry. See <https://plato.stanford.edu/entries/climate-science/#:~:text=Climate%20science%20investigates%20the%20structure,which%20they%20change%20over%20time.&text=Some%20key%20questions%20and%20findings%20about%20anthropogenic%20climate%20change%20are%20also%20discussed>.

Massachusetts v. EPA, which held that the Clean Air Act gives the Environmental Protection Agency the authority to regulate carbon and other greenhouse gases because such gases are pollutants.² Russell noted that the date of the court case corresponds with an “inflection point in U.S. emissions.”

Russell stated that scientists are interested in top-down methods for estimating emissions, with a focus on what can be verified through direct measurements of atmospheric and oceanic gases, as opposed to bottom-up methods which are self-reported by emissions producers. She said that in the past there had been a great deal of measurement uncertainty in the oceans, despite the fact that “93% of the energy imbalance caused by this increased CO₂ and other greenhouses gases is going into the oceans.” She then described the deployment of hundreds of robot floats placed in the oceans since 1999 as a “revolution in how we account for carbon,” reducing the uncertainty and allowing for the ability to measure emissions in the oceans. Such measurements allow for an almost real-time accounting of carbon emissions and will allow for finer resolution in time and space.

The panel’s second speaker, **Veerabhadran Ramanathan** (Scripps Institute of Oceanography), spoke about the science of attribution, how we know which environmental changes are due to human actions, and the associated public health risks. He stated that one way to judge theories and model projections is to test predictions, and that many predictions, from as far back as 100 years ago, have “all been confirmed by observation.” Such predictions include increased humidity of the atmosphere, amplified warming in polar regions, and a timeline for warming due

² 549 U.S. 497 (2007),

to human activities. Ramanathan also stated that if there are any flaws in the predictions, it is that the changes “are a lot more drastic than what was predicted,” including “new weather extremes” such as droughts and fires.

Ramanathan also discussed the economic and public health costs of the gradual warming and resultant extreme weather events. He said that the Centre for Research on the Epidemiology of Disasters and the United Nations Office for Disaster Risk Reduction estimates that, in the last 25 years, “600,000 lives have been lost globally to climate related incidents, and more than 3.5 billion people have been displaced.”³ He noted that such statistics and evidence will be used in any future discussion about climate change.

Benjamin D. Santer (Lawrence Livermore National Laboratory) identified three issues that may be relevant to climate change litigation: climate fingerprinting; event attribution; and satellite temperature data. He described climate fingerprinting as recognizing the various characteristics and signatures that different influences have on the climate system. Such signatures are easier to discern if scientists study patterns. Santer emphasized the importance of “prob[ing] beyond one number...and look[ing] at complex patterns of climate change.” He noted the importance of testable hypotheses, which can rule out non-human-driven explanations by examining data produced by satellites and other measurements.

³ See Center for Research on the Epidemiology of Disasters and United Nations Office of Disaster Risk Reduction, *The Human Cost of Climate Related Disasters, 1995-2015*, 2015, available at: https://www.preventionweb.net/files/46796_cop21weatherdisastersreport2015.pdf.

Santer discussed event attribution as a field that “is very relevant for the courts” and one that was “kick started” by the 2003 European heat wave. Using models similar to those used by epidemiologists, climate scientists are able to compare the likelihood of an event with no human changes in greenhouse gases with the likelihood of the same event with “human caused changes of greenhouse gases.” Santer said that satellite temperature data show that temperatures measurements from 1979 to the present have increased and that these changes demonstrate the “warming of the lower atmosphere and cooling of the upper atmosphere.” These types of measurements were presented as further evidence of “human effects on global climate.”

Santer listed potential relevant legal issues for judges to consider with regard to climate science, including when and where the hazard is likely to occur, the scientific confidence in the projected climate change hazard, the robustness of the effect across dozens of different climate models, and the reliability of the attribution and estimations of human contributions to the change.

The panel’s final speaker, **Donald J. Wuebbles** (University of Illinois), spoke about estimating climate impacts, and the range and uncertainty inherent in scientific models. Complex climate models based on physics, chemistry, and biology give us the ability to represent the atmosphere and determine potential temperature changes. Using such models, scientists can generate scenarios of higher and lower fossil fuel use, and from these scenarios “determine the potential temperature changes in our planet.” Such models include ranges and uncertainty in climate projections, but “do a pretty good job of representing what’s going on on the earth,” particularly “at a global scale.” Wuebbles stated that “future [climate] scenarios are driven by human activities, which we can’t predict” but that “by the end of the century...we are going to see a

very significant impact on the U.S. economy.” Impacts are already apparent in every region and in important sectors such as health, water, agriculture, and energy. He noted that there are three ways for humans to react to climate change: mitigation, adaptation, or suffering. “Right now,” Wuebbles said, “we are doing all three.”

Discussion

In the discussion session, questions were raised about the admissibility of climate change evidence in court and about how best to write a *Reference Manual* chapter that it is accessible to judges who might be more questioning of climate science’s methods and conclusions. O’Malley asked whether there were well-trained scientific experts who would refute claims of climate change with theories that would be admissible under the standards of evidence. Santer said that while there may be one or two scientists willing to testify under oath that the causes of climate change are natural ones, in his opinion, those voices are not credible ones. Tatel asked if panelists had any suggestions for how to write a *Reference Manual* that is “credible to judges who are themselves perhaps climate skeptics.” Panelists suggested reports from the National Academies and the Environmental Law Institute’s judicial education programs might be useful resources. Panelists and members of the workshop planning committee acknowledged the difficulty of writing a chapter on climate science and emphasized the importance of presenting arguments objectively and in a “way that is credible and respectful of the scientists and the judges.”

Other questions related to the idea of attribution, precision of measurement, and the likelihood of assigning responsibility for specific sources of pollution to specific companies or individuals.

Panelists replied that the infrastructure to monitor CO₂ and other pollutants has developed significantly—this has led to more precise measurements in real time and technology is accelerating to a point where such identifications may be possible.

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